

**SECTION 9-14 EROSION AND LANDSCAPE MATERIALS****9-14.1 SOILS**

The following soils and soil mixes are specified on Drawings or by the Engineer, according to project needs, and are all subject to the General Testing and Submittal Requirements of 9-14.1(A):

1. **Topsoil Type A - Imported.** A general purpose mix of Sandy Loam and compost as needed to meet minimum organic matter content requirements. Similar to Washington State Department of Transportation's Topsoil Type A specification.
2. **Reused Amended Site Soil.** Soil from the Project Site that is either amended in place or moved/stockpiled during grading operations and then amended with compost as needed to meet minimum organic matter content requirements.
3. **Bioretention Soil.** An imported mix made of Mineral Aggregate and compost specified to meet the infiltration and filtration requirements of stormwater management structures. For Project Sites located within the City limits of Seattle; Bioretention Soil shall be procured only from approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
4. **Planting Soil.** An imported soil mix for planting beds, planted medians and planting strips.
5. **General Turf Area Soil.** An imported soil mix for passive-recreation turf areas.
6. **High Performance Turf Mixes.** An imported soil mix for intensive-use turf areas, including three different mixes of sand and compost to optimize drainage and fertility in different sites and uses.

**9-14.1A GENERAL TESTING AND SUBMITTAL REQUIREMENTS**

At least 10 Working Days prior to placement of any soils specified in Section 9-14, the Contractor shall submit to the Engineer the following in accordance with Section 1-05.3. All test results shall be from samples sampled and tested less than 90 days prior to date of submittal.

1. **Aggregate and Loam Analysis.** Grain size analysis results of the Mineral Aggregate or Sandy Loam portion of each soil mix, performed by an accredited laboratory in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
2. **Compost Analysis.** Quality analysis results for the compost portion of each soil mix performed in accordance with STA standards, as specified in Section 9-14.4(8).
3. **Mix Analysis.** Test results from an accredited soil laboratory, including the following parameters:
  - a. Total Nitrogen and Soluble Nitrogen (NO<sub>3</sub> + NH<sub>3</sub>)
  - b. Phosphorous
  - c. Potassium
  - d. pH
  - e. Organic Matter % (Loss on Ignition method)
  - f. Conductivity
  - g. Calcium
  - h. Sulfur
  - i. Boron
  - j. Weed seed (for General Turf Area Soil and High Performance Turf Mixes)
4. **Recommendations.** Fertilizer and amendment recommendations for the specified plant type (turf, shrubs/groundcovers, or annuals: with special provisions for Bioretention applications) and soil application depth; from the accredited laboratory, an accredited Soil Scientist or Agronomist.
5. **Mix Samples.** Two one (1) gallon samples of each soil mix (two five (5) gallon samples for Bioretention and High Quality Turf Mixes).
6. **Manufacturer.** The Manufacturer's Certificate(s) of Compliance per Section 1-06.3 from the Supplier of the soil mix, and (if different) the Suppliers of the compost, including their name(s) and address(es).
7. **Laboratory Information.** Include the following information about the testing laboratories:
  - a. name of laboratory(ies) including contact person(s),
  - b. address(es),
  - c. phone contact(s),
  - d. e-mail address(es),
  - e. qualifications of laboratory and personnel including date of current certification by STA, ASTM, AASHTO, or approved equal.
8. **Acceptance of Soils Prior to Placement.** The Contractor shall not place any soils or soil mixes specified in Section 9-14 until the Engineer has reviewed and confirmed the following:
  - a. **Soil mix delivery ticket(s).** Delivery tickets shall show that the full delivered amount of soil matches the product type, volume and Manufacturer named in the submittals.
  - b. **Visual match with submitted samples.** Delivered product will be compared to the submitted sample, to verify that it matches the submitted sample.

The Engineer may inspect any loads of soil on delivery and stop placement if it is determined that the delivered soil does not appear to match the submittals; and require sampling and testing of the delivered soil, before authorizing soil placement. All testing costs shall be the responsibility of the Contractor.

#### 9-14.1(1) TOPSOIL TYPE A - IMPORTED

1. **Source.** Topsoil Type A shall consist of an imported Sandy Loam as defined by the United States Department of Agriculture Classification System, and documented by a Particle Size Analysis performed by an accredited laboratory.
2. **Organic Content.** Topsoil Type-A shall have an organic matter content of at least 5% by dry weight where turf will be installed, and at least 10% by dry weight for all other landscape areas. Organic matter shall be determined by Loss-on-Ignition test (ASTM D2974, or TMECC 05.07A). If additional organic content is needed meet these requirements, soil shall be amended with Compost meeting requirements in 9-14.4(8). Compost amendment requirements may be added at default rates of 22% by volume for turf or 38% for planting beds (1.75" amendment tilled to 8" depth for turf, 3" amendment tilled to 8" depth for beds); or calculated based on tests of the soil and compost, using the Soil Amendment Rate Calculator at <http://your.kingcounty.gov/solidwaste/compost-calculator.htm> or similar calculator available at [http://www.soilsforsalmon.org/excel/Compost\\_Calculator.xls](http://www.soilsforsalmon.org/excel/Compost_Calculator.xls).
3. **Sieve.** In addition to meeting the particle size requirements of USDA Sandy Loam, Topsoil Type-A shall meet the following sieve specifications:

Sieve Size	Percent Passing (weight)
1"	100%
1/2"	>90%
No.10	>70%

4. **Contaminants.** Topsoil Type-A shall be free from: Materials toxic to plant growth; visible seeds, rhizomes or roots; any King County-listed noxious weeds, or invasive root-propagating plants including but not limited to horsetail, ivy, clematis, knotweed, etc. Soil found to contain these prohibited viable plant materials shall be removed and replaced at the Contractor's expense
5. **Testing and Submittals.** Testing and submittals shall comply with all provisions of 9-14.1.

#### 9-14.1(2) REUSED AMENDED SITE SOIL

1. **Source.** Reused Amended Site Soil shall be native topsoil taken from within the Project Site, either from areas where construction excavation is to be performed; from borrow, pit, or quarry sites strippings; or other designated sources. The general limits of the Material to be utilized for topsoil will be indicated in the Contract. The Engineer will make the final determination of the areas where the most suitable Material exists within these general limits, and depth of excavation. The Contractor shall reserve this Material for the specified use.
2. **Unwanted Vegetation.** In the production of Reused Amended Site Soil, all vegetative matter shall become a part of the topsoil, except large brush and trees over 4 feet in height. Prior to removal, the Contractor shall mow or otherwise reduce the height of the native vegetation such to a height not exceeding 1 foot. Plants on the King County Noxious Weed Lists or invasive root-propagating plants including but not limited to horsetail, ivy, clematis, knotweed, etc., shall not be incorporated in the topsoil. Such plants shall be removed and disposed.
3. **Organic content.** The final Reused Amended Site Soil shall have a minimum organic matter content by dry weight of 5% for areas where turf will be installed, and 10% for all other landscape areas. Organic matter shall be determined by Loss-on-Ignition test (ASTM D2974, or TMECC 05.07A). Native site topsoil shall be amended with Compost as described in 9-14.4(8), if more organic content is needed to meet these requirements. Compost amendment requirements may be added at default rates of 22% by volume for turf or 38% for planting beds (1.75" amendment tilled to 8" depth for turf, 3" amendment tilled to 8" depth for beds); or calculated based on tests of the soil and compost, using the Soil Amendment Rate Calculator at <http://your.kingcounty.gov/solidwaste/compost-calculator.htm> or similar calculator available at [http://www.soilsforsalmon.org/excel/Compost\\_Calculator.xls](http://www.soilsforsalmon.org/excel/Compost_Calculator.xls).
4. **Stockpiling.** Designated Material shall be placed at locations approved by the Engineer that do not interfere with the construction of the Project. The Contractor shall take all precautions to avoid disturbing the existing ground beyond the Project Site or other areas designated by the Engineer.
5. **Testing and Submittals.** Testing and submittals shall comply with all provisions of 9-14.1

#### 9-14.1(3) BIORETENTION SOIL

1. **Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure bioretention soil Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
2. **Mix Components.** Bioretention Soil shall be a well-blended mixture of Mineral Aggregate and compost measured on a volume basis. Bioretention Soil shall consist of approximately two parts fine compost (approximately 35 to 40 percent) by volume meeting the requirements of Section 9-14.4(8) and three parts Mineral Aggregate (approximately 60 to 65 percent), by volume meeting the requirements of Section 9-03.2(2). The mixture shall be well blended to

produce a homogeneous mix, and have an organic matter content of 4% to 8% determined using the Loss on Ignition Method.

#### 9-14.1(4) PLANTING SOIL

1. **Mix.** Planting soil shall consist of a mix of 2 to 3 parts Sandy Loam soil and 1 part compost by volume. The resulting mix shall contain approximately 8-15% organic matter by weight, tested by the Loss on Ignition method.
2. **Sandy Loam.** Shall be imported and shall be as defined by the United States Department of Agriculture Classification System, and documented by a Particle Size Analysis performed by an accredited laboratory. The sandy loam fraction of mix shall be screened through a 1/2" mesh, to remove all rocks, plant parts and other debris.
3. **Compost.** Compost used shall meet the definition of Compost in 9-14.4(8).
4. **Contaminants.** Sandy Loam shall be free from: Materials toxic to plant growth; visible seeds, rhizomes or roots; for any King County-listed noxious weeds, or invasive root-propagating plants including but not limited to horsetail, ivy, clematis, knotweed, etc.
5. **Testing and Submittals.** Testing and submittals shall comply with all provisions of 9-14.1.

#### 9-14.1(5) GENERAL TURF AREA SOIL

**General.** General Turf Area Soil is for general-use and passive recreation lawn areas, in areas where year-round maintenance and positive drainage are important. For sports fields or high-traffic lawn areas such as Seattle Center, the Contractor shall use High Performance Turf Mix, per 9-14.1(5).

1. **Mix.** General Turf Area Soil shall consist of 2 parts sand meeting the requirements below, and 1 part Compost by volume. The resulting mix shall contain approximately 4-6% organic matter by weight, tested by the Loss on Ignitions method.
2. **Sand.** Sand used shall meet the following particle distribution.

Screen Size	Percent Retained
3/8 inch	0
#4	<3%
#6	<5%
#10	<20%
#18	<20%
#20	25-50%
#30	
#35	
#40	>20%
#60	
#100	<10%
#200	<5%
#270	<5%
2um	<5%
<2um	<3%

3. **Compost.** Compost used shall meet the definition of Compost in 9-14.4(8) and be certified in compliance with the US Composting Council STA program.
4. **Testing and Submittals.** Testing and submittals shall comply with all provisions of 9-14.1
5. **Weed Seeds and Propagules.** General Turf Area Soil shall not contain any viable seeds or roots capable of sprouting of any State-listed noxious weed, or invasive root-propagating plants including but not limited to horsetail, ivy, clematis, knotweed, etc. Soil found to contain these prohibited viable plant materials shall be removed and replaced at the Contractor's expense.

#### 9-14.1(6) HIGH PERFORMANCE TURF SOIL

**General:** High Performance Turf Soil is for athletic fields or high traffic lawn areas such as those used for events, with sub-surface drainage and in-ground irrigation.

1. **Mix.** High Performance Turf Soil shall consist of 80% - 95% quartz based sands, uniformly blended with 5% - 20% compost by volume. The ratio of sand to organic amendment shall be determined by the Engineer, depending on the intended turf use:
  - a. High Performance - Standard Mix: 90% sand plus 10% compost
  - b. High Performance - Fertility Mix: 80% sand plus 20% compost
  - c.. High Performance - Drainage Mix: 95% sand plus 5% compost

2. **Mineral Aggregate.** Sand shall be free of weed seeds and propagules; and meet the following particle size distribution with a Coefficient of Uniformity between 2.5 and 4.5:

Size Fraction	Particle Size Range	Screen	Incremental % retained	
Gravel	3/8"	3/8"	0%	
Gravel	>4.75 mm	#4	<3%	<30% combined

Gravel	3.4 to 4.75 mm	#6	<5 %	>60% of sand
Fine gravel	2.0 to 3.4 mm	#10	<20 %	
Very coarse sand	1.0 to 2.0 mm	#18	<20 %	
Coarse sand	0.5 to 1.0 mm	#35	25 to 50 %	
Medium sand	0.25 to 0.5 mm	#60	>20 %	
Fine sand	0.15 to 0.25 mm	#100	<10 %	<15% combined
Very fine sand	0.05 to 0.15 mm	#270	<5 %	
Silt	0.002 to 0.05 mm	By Hydrometer	<5 %	
Clay	<0.002 mm		<3 %	

3. **Compost Amendment.** Compost used shall be free of weed seeds and propagules, and meet the definition of Compost in 9-14.4(8).
4. **Offsite Blending.** Sand and organic amendment shall be thoroughly blended off site, after samples of sand and amendment have been submitted for testing and approval.
5. **Test Submittals.** At least 10 Working Days prior to placement of High Performance Turf Soil, the Contractor shall submit to the Engineer the following in accordance with Section 1-05.3:
  - a. **Compost.** Analysis performed in accordance with STA standards, as specified in Section 9-14.4(8);
  - b. **Sand.** Grain size analysis results of the Mineral Aggregate performed by an independent laboratory in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
  - c. **Mix.** Report the following parameters, from an accredited independent lab. Testing and recommendations shall be at the Contractor's expense.
    - i. **pH**
    - ii. **Organic Matter.** Using the Walkley-Black Method.
    - iii. **Nutrients:** Total Nitrogen, NO-3 and NH-3; Phosphorus, Potassium, Calcium, Sulfur, Magnesium, Boron.
    - iv. **Conductivity.**
    - v. **Weed Seeds.** High Performance Turf Mixes shall be free of viable weed seeds or propagules, as determined by bioassay using TMECC 05.09-A, Shields Rinse Method.
    - vi. **Amendment Recommendations.** Fertilizer and amendment recommendations for turf, from an accredited Agronomist or Soil Scientist.
    - vii. **Laboratory Information.** Name, address, phone and e-mail contact information; and qualifications of laboratory and personnel including a copy of current certification by STA, AAHTO, or approved equal.
6. **Mix Samples.** At least 10 Working Days prior to placement of High Performance Turf Soil, the Contractor shall submit to the Engineer two five (5) gallon samples of the High Performance Turf Mix, along with the following information:
  - a. The Manufacturer's Certificate(s) of Compliance per Section 1-06.3 accompanying the test results from the Supplier of the High Performance Turf Mix, and (if different) the Suppliers of the mineral aggregate and compost components, including their name(s) and address(es);
  - b. A description of the equipment and methods to mix the Mineral Aggregate and compost to produce High Performance Turf Mix.
7. **Acceptance of Mix Prior to Placement.** The Contractor shall not place High Performance Turf Soil until the Engineer has reviewed and confirmed the following:
  - a. **Soil mix delivery ticket(s).** Delivery tickets shall show that the full delivered amount of High Performance Turf Soil matches the product and Manufacturer named in the submittals.
  - b. **Visual match with submitted samples.** Delivered product will be compared to the submitted 5-gallon sample, to verify that it matches the submitted sample.

The Engineer may inspect the High Performance Turf Soil on delivery and stop placement if (s)he determines that the delivered soil does not appear to match the submittals; and require sampling and testing of the delivered soil, before authorizing soil placement. All testing shall be conducted at the Contractor's expense.

## 9-14.2 SEED

### 9-14.2(1) GENERAL

1. **Grade.** Grasses, legumes, or cover crop seed of the type specified shall conform to the standards for "Certified" grade seed or better as outlined by the State of Washington Department of Agriculture "Rules for Seed Certification", current edition.
2. **Package and Labels.** Seed shall be furnished in standard sealed containers and shall include the following information:
  1. Common name of seed,
  2. Name of variety, when applicable
  3. Lot number,
  4. Net weight,
  5. Percentage of purity,

6. Percentage of germination (in case of legumes percentage of germination to include hard seed), and
7. Percentage of weed seed content and inert material clearly marked for each kind of seed in accordance with applicable State and Federal law.
8. Germination test date.
3. **Test Certification.** Upon request, the Contractor shall furnish to the Engineer duplicate copies of a statement signed by the Materialperson certifying that each lot of seed has been tested by a recognized and accredited seed testing laboratory within six months before the date of delivery to the Project Site. Seed which has become wet, moldy, or otherwise damaged in transit or storage will not be accepted.
4. **Approved Turf Seed Varieties:** Turf varieties shall include only those ranked "Best" by the 2011 or most current succeeding year's WSU "Turfgrass Cultivars Evaluated In Western Washington/Oregon In Recent Years" list. ([Puyallup.wsu.edu/turf](http://Puyallup.wsu.edu/turf))

#### 9-14.2(2) SEED MIX #1 (EROSION MIX)

1. **Seed Mix.** The seed mixture and rate of application shall be as follows:

Kind and Variety of Seed in Mixture	Percent by Weight
Turf-type Perennial Rye Blend (2 or more varieties)	50%
Creeping Red Fescue	20%
Chewings Fescue	20%
Hard Fescue	10%

2. **Seeding Rate.** The rate of application shall be 5 pounds per 1000 square feet.
3. **Seed Quality.** The seed mixture shall be no less than 98% pure, shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. No noxious weeds will be permitted. Seed shall be certified grown in Washington, Oregon or Idaho and tagged with the information required in 9-14.2(1)

#### 9-14.2(3) SEED MIX #2 (NON-IRRIGATED LAWN SEED MIX)

1. **Seed Mix.** The seed mixture and rate of application shall be as follows:

Kind and Variety of Seed in Mixture	Percent by Weight
Turf-type Perennial Rye (2 or more varieties)	50%
Chewings Fescue	30%
Hard Fescue	20%

2. **Seeding Rate.** The rate of application shall be 6 pounds per 1000 square feet.
3. **Seed Quality.** The seed mixture shall be no less than 98% pure, and shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. No noxious weeds will be permitted. Seed shall be certified grown in Washington, Oregon or Idaho and tagged with the information required in 9-14.2(1)

#### 9-14.2(4) SEED MIX #3 (IRRIGATED LAWN OR ATHLETIC TURF AREA)

1. **Seed Mix.** The seed mixture and rate of application shall be as follows:

Kind and Variety of Seed in Mixture	Percent by Weight
Turf-type Perennial Rye (3 approved varieties)	100%

2. **Seeding Rate.** The rate of application shall be 6 pounds per 1000 square feet.
3. **Seed Quality.** The seed mixture shall be no less than 98% pure, and shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. No noxious weeds will be permitted. Seed shall be certified grown in Washington, Oregon or Idaho and tagged with the information required in 9-14.2(1)

#### 9-14.2(5) SEED MIX #4 (BIOFILTRATION SWALE MIX)

1. **Seed Mixes.** The seed mixture and rate of application shall be as follows:

Wet Biofiltration Swale Mix		Biofiltration Swale Mix	
Kind and Variety	Percent by Weight	Kind and Variety	Percent by Weight
Tall fescue or meadow fescue <i>Festuca arundinacea</i> or <i>Festuca elatior</i>	60-70 percent	Tall or meadow fescue <i>Festuca arundinacea</i> or <i>Festuca elatior</i>	75-80 percent

Seaside/Colonial bentgrass <i>Agrostis palustris</i>	10-15 percent	Seaside/Colonial bentgrass <i>Agrostis palustris</i>	10 -15 percent
Meadow foxtail <i>Alepocurus pratensis</i>	10-15 percent	Redtop bentgrass <i>Agrostis alba</i> or <i>A. gigantea</i>	5-10 percent
Alsike clover <i>Trifolium hybridum</i>	6-10 percent		
Redtop bentgrass <i>Agrostis alba</i>	1-6 percent		

\*Modified Briargreen, Inc Hydroseeding Guide Wetlands Seed Mix

## 2. Seeding Rate.

The rate of application shall be:

- Wet Biofiltration Swale Mix: 4 pounds per 1000 square feet.
- Biofiltration Swale Mix: 6 pounds per 1000 square feet.

- Seed Quality.** The seed mixture shall be no less than 98% pure, and shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. No noxious weeds will be permitted.

### 9-14.2(6) SEED MIX #5 (LOW GROWING, DROUGHT TOLERANT GRASS AND HERBACEOUS MIX)

- Seed Mix.** The seed mixture and rate of application shall be as follows:

Kind and Variety	Percent by Weight
Dwarf Perennial Rye	50-70%*
Hard Fescue	0-20%*
Strawberry Clover ( <i>Trifolium fragiferum</i> )	5%
Dutch White Clover ( <i>Trifolium repens</i> )	5%
Microclover	5%
Dwarf Yarrow, <i>Achillea millefolium</i> or <i>Achillea X Lewisii</i> vars.	5%
Sweet Alyssum, <i>Lobularia maritima</i>	5%
English Daisy, <i>Bellis perennis</i>	5%

\* Dwarf Perennial Rye and Hard Fescue shall make up a combined 70% of mix.

- Seed Quality.** The seed mix shall be no less than 98% pure and shall have a minimum germination rate of 90%, and contain less than 1.5% inert material. Seed shall be tagged with the information required in 9-14.2(1).
- Application Rate and Method.** The Contractor shall submit, and receive approval from the Engineer at least 3 Working Days before ordering, all species included in the wildflower mix and the Materialperson's written directions on how to apply the seed mix. Written directions shall include rate of application and the incorporation of specific species of grass seed components when appropriate to achieve adequate erosion control protection while maximizing flower display and regeneration.
- Prohibited Species.** Noxious weeds (Chapter 16-750 WAC), and invasive species listed by the Washington State Noxious Weed Control Board, will not be allowed.

### 9-14.3 FERTILIZER

#### 9-14.3(1) GENERAL

- Type and Application Rates.** Fertilizers shall be applied in a form and at a rate recommended by a Certified Agronomist or Soil Scientist, based on soil analysis by an independent accredited laboratory, as specified in 9-14.1(A) General Testing and Submittal Requirements.
- Slow-Release Nitrogen.** A minimum of 50% of nitrogen fertilizer shall be applied in a slow- or controlled-release form; such as sulfur- or polymer-coated urea, IBDU, trinitromethane (Nitroform), or organic forms.

3. **Package and Labeling.** All fertilizers shall be furnished in standard sealed and unopened containers with weight, name of plant nutrients and manufacturer's guaranteed statement of analysis clearly marked, all in accordance with State and Federal law.
4. **Submittals.** The Contractor shall submit to the Engineer for approval at least 5 Working Days in advance, an analysis of the proposed fertilizer, a 5 pound sample, and Manufacturer's Certificate of Compliance indicating all Specifications are met.

#### 9-14.3(2) LIME

1. **Analysis.** Lime composition (dolomitic or non-dolomitic) shall be determined based on laboratory analysis and recommendations submitted per 9-14.1(3 and 4).
2. **Application rate.** Lime application rate shall be determined based on laboratory analysis and recommendations submitted per 9-14.1(3 and 4).
3. **Form.** Lime form (prill type or flour) will be determined based on laboratory analysis and recommendations submitted per 9-14.1(3 and 4).

#### 9-14.4 MULCHES AND AMENDMENTS

The following mulches and amendments are specified on the Drawings or by the Engineer, according to project needs, and may be subject to testing needs as specified in other sections:

1. **Straw Mulch.** 9-14.4(1). Generally used as a temporary mulch to cover seed for erosion control seeding.
2. **Wood Fiber Mulch.** 9-14.4(2). Used to protect seed and soil in turf and erosion control hydroseeding applications.
3. **Bark Mulch.** 9-14.4(3). Used in woody plant beds to protect soil, conserve moisture, and provide long-term nutrients.
4. **Arborist Wood Chip Mulch.** 9-14.4(4). Clean recycled wood chip from tree-trimming, composting operations or wood reclamation operations; used as the standard mulch for woody plants. For Project Sites located within the City limits of Seattle; arborist wood chip mulch shall be procured only from approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
5. **Peat.** 9-14.4(5). An amendment typically only used for moisture management in potting mixes and container plantings. More widespread use of peat has been replaced with compost and related products.
6. **Vermiculite, Perlite and Pumice.** 9-14.4(6). Specialty materials typically only used to improve moisture management in potting mixes, container plantings, and green roofs.
7. **Tackifier.** 9-14.4(7). An amendment used in hydroseeding mixtures to hold seed and mulch in place.
8. **Compost.** 9-14.4(8). An amendment used in all types of soil mixes to supply organic matter, nutrients, and moisture management properties. Also used in mulches, potting soils, and erosion control applications such as socks and berms. For Project Sites located within the City limits of Seattle; compost shall be procured only from approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).

#### 9-14.4(1) STRAW MULCH

**Quality.** All straw mulch Material shall be in an air-dried condition free of noxious weeds and other materials detrimental to plant life. Straw shall be seasoned before baling or loading and shall be suitable for spreading with mulch blower equipment.

#### 9-14.4(2) WOOD FIBER MULCH

1. **Quality.** Wood fiber mulch shall be specially processed 100 percent wood fiber in which 30% of the fibers shall be 0.15 inches long or longer and which shall have tackifier added to the mulch during the manufacturing process. Mulch shall contain no growth or germination-inhibiting ingredients and shall be dyed a suitable color to facilitate inspection of placement of the Material. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the Material become uniformly suspended to form a homogenous slurry. When hydraulically sprayed on the ground, the Material shall allow the absorption and percolation of moisture. Each package of cellulose fiber shall be marked by the manufacturer to show the air dry weight content.
2. **Application.** Tackifier shall not be applied at temperatures below 50°F nor in wet or rainy weather. A minimum of 4 to 6 hours of curing time is required for acceptance of the application. See Section 9-14.2(5) for condition where the addition of tackifier is required for biofiltration swale seed mix.
3. **Terrain** that is steeper than 2H:1V, areas that exceed 10,000 square feet, and areas having a vertical drop greater than 15 feet shall be treated with a supplemental tackifier in accordance with Section 9-14.4(7).
4. **Application Rate.** Mulch shall be applied at the following rates depending on the slope of the terrain:
  - a. 35 pounds per 1000 square feet, or 1500 pounds per acre, for areas having zero to 4H:1V slope.
  - b. 50 pounds per 1000 square feet, or 2000 pounds per acre, for areas having between 2H:1V and 4H:1V slope.
  - c. 60 pounds per 1000 square feet, or 2500 pounds per acre, for areas having a slope greater than 2H:1V.

#### 9-14.4(3) BARK MULCH

1. **Quality.** Bark mulch shall consist of freshwater Douglas fir, pine, or hemlock bark. It shall be ground so that on a loose volume basis, a minimum of 95 percent passes a 1-1/2 inch sieve and no more than 55 percent passes a 1/4



inch sieve. The bark mulch shall not contain salts, resin, tannin, or any other deleterious material in quantities that would be detrimental to plant life.

2. **Wood Chip Alternative.** Wood chips salvaged from clearing and grubbing activity may be approved as a substitute for bark mulch, if found acceptable by the Engineer prior to application. Arborist wood chip mulch, 9-14.4(4), may also be used as a substitute for bark mulch when approved by the Engineer.

#### 9-14.4(4) ARBORIST WOOD CHIP MULCH

1. **Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure arborist wood chip mulch Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
2. **Quality.** Arborist Wood Chip Mulch (AWCM) shall be coarse ground wood chips (approximately 1/2" to 6" along the longest dimension) derived from the mechanical grinding or shredding of the above-ground portions of trees. It may contain wood, wood fiber, bark, branches, and leaves; but may not contain visible amounts of soil. It shall be free of weeds and weed seeds including but not limited to plants on the King County Noxious Weed list available at: [www.kingcounty.gov/weeds](http://www.kingcounty.gov/weeds), and shall be free of invasive plant portions capable of resprouting, including but not limited to horsetail, ivy, clematis, knotweed, etc. It may not contain more than 1/2% by weight of manufactured inert material (plastic, concrete, ceramics, metal, etc.).
3. **Gradation.** Arborist Wood Chip Mulch, when tested, shall meet the following loose volume gradation:

Sieve Size	Percent Passing	
	Minimum	Maximum
2"	95	100
1"	70	100
5/8	0	50
1/4"	0	40

No particles may be longer than eight inches.

4. **Submittals.** At the Engineer's request, prior to delivery the Contractor shall provide the following:
  - a. The source of the product and species of trees included in it;
  - b. A sieve analysis verifying the product meets the above size gradation requirement;
  - c. A 5 gallon sample of the product, for the Engineer's approval.

#### 9-14.4(5) PEAT

**Quality.** Peat shall be derived from 100% sphagnum, and shall conform to ASTM D 2607 unless otherwise specified in the Contract. Peat shall be shredded and granulated to pass a 1/2 inch sieve and conditioned in storage piles for at least six months after excavation. The peat shall not contain substances harmful to plant life.

#### 9-14.4(6) VERMICULITE / PERLITE / PUMICE

**Quality.** Vermiculite, perlite, and pumice shall be horticultural grade and free of any toxic materials.

#### 9-14.4(7) TACKIFIER

**Quality.** Tackifier used to stabilize mulch shall provide a liquid soil bonding agent which gives immediate erosion protection and remains effective for a minimum of one full year on an undisturbed site.

#### 9-14.4(8) COMPOST

1. **Procurement.** For Project Sites located within the City limits of Seattle; the Contractor shall procure compost Materials from only approved sources as specified by the City of Seattle, City Purchasing and Contracting Services (<http://www.seattle.gov/contracting/construction.htm>).
2. **Quality.** Compost production and quality shall comply with Chapter 173-350 WAC, and meet the criteria below:
3. **Regulatory Standards.** Compost products shall be the result of the biological degradation and transformation of feedstocks as specified below, under controlled conditions designed to promote aerobic decomposition, per WAC 173-350-220, which is available at <http://www.ecy.wa.gov/programs/swfa/compost>
4. **Submittals.** The Contractor shall submit the following information to the Engineer for approval:
  - a. A copy of the Solid Waste Handling Permit issued to the supplier by the Jurisdictional Health Department as per WAC 173-350 (Minimum Functional Standards for Solid Waste Handling).
  - b. The Supplier shall verify in writing, and provide lab analyses that the Materials comply with the processes, testing, and standards specified in WAC 173-350 and these Specifications. An independent STA Program certified laboratory shall perform the analysis.
  - c. A list of the feedstock by percentage present in the final compost product.
  - d. A copy of the producer's current STA certification as issued by the U.S. Composting Council.
  - e. Acceptance shall be based upon a satisfactory Test Report from an independent STA program certified laboratory and the sample(s) submitted to the Engineer.
5. **Testing Requirements.** The compost Supplier shall test all compost products within 90 Calendar Days prior to application, at the Suppliers expense. Samples shall be collected using the Seal of Testing Assurance (STA) sample collection protocol, available from the U.S. Composting Council, Phone: 631-737-4931, [www.compostingcouncil.org](http://www.compostingcouncil.org).



The sample shall be tested by an independent STA Program certified laboratory. A copy of the approved independent STA Program laboratory test report shall be submitted to the Engineer prior to initial application of the compost.

6. **Gradation.** Compost shall meet the following size gradations when tested in accordance with the U.S. Composting Council "Testing Methods for the Examination of Compost and Composting" (TMECC) Test Method 02.02-B, "Sample Sieving for Aggregate Size Classification":

- a. **Fine Compost.** Fine Compost, typically used for soil amendment, shall meet the following gradation by dry weight:

	Min.	Max.
Percent passing 2"	100%	
Percent passing 1"	99%	100%
Percent passing 5/8"	90%	100%
Percent passing 1/4"	75%	100%

- b. **Coarse Compost.** Coarse Compost, typically used for erosion control or surface mulching, shall meet the following gradation by dry weight:

	Min.	Max.
Percent passing 3"	100%	
Percent passing 1"	90%	100%
Percent passing 3/4"	70%	100%
Percent passing 1/4"	40%	60%

7. **pH.** The pH shall be between 6.0 and 8.5 when tested in accordance with TMECC 04.11-A; "1:5 Slurry pH".
8. **Physical Contaminants.** Manufactured inert material (concrete, ceramics, metal, etc.) shall be less than 1.0 percent by weight as determined by TMECC 03.08-A "percent dry weight basis". Film plastics shall be 0.1% or less, by dry weight.
9. **Organic Content.** Minimum organic matter content shall be 40 percent by dry weight basis as determined by TMECC 05.07A; "Loss-On-Ignition Organic Matter Method".
10. **Salinity.** Soluble salt contents shall be less than 5.0 mmhos/cm tested in accordance with TMECC 04.10-A; "1:5 Slurry Method, Mass Basis".
11. **Maturity.** Maturity shall be greater than 80% in accordance with TMECC 05.05-A; "Germination and Vigor". The Engineer may also evaluate compost for maturity using the Solvita Compost Maturity Test at time of delivery. Fine Compost shall score a number 6 or above on the Solvita Compost Maturity Test. Coarse Compost shall score a 5 or above on the Solvita Compost Maturity Test.
12. **Stability.** Stability shall be 7 or below in accordance with TMECC 05.08-B; "Carbon Dioxide Evolution Rate".
13. **Feedstocks.** The compost product shall contain a minimum of 65 percent by volume from recycled plant waste as defined in WAC 173-350-100 as "Yard waste", "Crop residues", and "bulking agents". A maximum of 35 percent by volume of "post-consumer food waste" as defined in WAC 173-350-100 may be substituted for recycled plant waste. A minimum of 10% food waste in compost is required. The Engineer may approve compost products containing up to 35% biosolids or manure feedstocks for specific projects or soil blends, but these feedstocks are not allowed unless specified, and not allowed in compost used for Bioretention Soils.
14. **C:N.** Fine Compost shall have a carbon to nitrogen ratio of less than 25:1 as determined using TMECC 04.01 "Total Carbon" and TMECC 04.02D; "Total Kjeldhal Nitrogen". The Engineer may specify a C:N ratio up to 35:1 for projects where the plants selected are entirely Puget Sound native species. Compost may be mixed with fir or hemlock bark meeting requirements of 9-14.4(3) to raise the C:N ratio above 25:1. Coarse Compost shall have a carbon to nitrogen ratio between 20:1 and 45:1.

#### 9-14.5 MATTING AND STAKES

##### 9-14.5(1) JUTE MATTING

##### 9-14.5(1)A JUTE MATTING FOR NON-STREAM APPLICATIONS

**Quality.** Jute matting shall be of a uniform open plain weave of unbleached, single jute yarn treated with a fire retardant chemical. The yarn shall be of a loosely twisted construction and shall not vary in thickness by more than 1/2 of its nominal diameter. Jute matting shall be furnished in rolled strips approximately 50 yards in length. Matting width shall be 48 inches with an average weight of 0.92 pound per square yard. A tolerance of  $\pm 1$  inch in roll width and  $\pm 5$  percent in weight per square yard will be allowed.

##### 9-14.5(1)B JUTE MATTING FOR IN-STREAM APPLICATIONS

- Quality.** Jute matting shall be of a uniform open plain weave of unbleached 100% jute yarn. Plastic, or any geosynthetic netting shall not be used for stream bank construction or restoration.
- Application.** The following table specifies acceptable product applications:

Slope	Minimum Criteria	Test Method
Slope $\geq$ 1:1	25 oz/sy <40% open area	ASTM D-3776 Corp of Engineers COE CW002215

3:1 < slope < 1:1	14 oz/sy <60% open area	ASTM D-3776 Corp of Engineers COE CW002215
4:1 < slope < 3:1	9 oz/sy <65% open area	ASTM D-3776 Corp of Engineers COE CW002215
Slope < 4:1	No matting required unless otherwise specified in the Contract.	

**9-14.5(2) COIR MATTING FOR IN-STREAM APPLICATIONS**

1. **Quality.** Coir matting shall be of a uniform open plain weave of unbleached 100% coir fabric from coconut husk. Plastic, or any geosynthetic netting shall not be used for stream bank construction or restoration.
2. **Application.** Coir matting shall meet and be installed in accordance with the following table:

Slope Application	Minimum Criteria	Test Method
Slope $\geq$ 1:1	25 oz/sy <40% open area	ASTM D-3776 Corp of Engineers COE CW002215
3:1 < slope < 1:1	14 oz/sy <60% open area	ASTM D-3776 Corp of Engineers COE CW002215
4:1 < slope < 3:1	9 oz/sy <65% open area	ASTM D-3776 Corp of Engineers COE CW002215
Slope < 4:1	No matting required unless otherwise specified in the Contract	

**9-14.5(3) EXCELSIOR MATTING**

1. **Quality.** Excelsior matting shall be a machine produced mat of wood excelsior covered on one side with a biodegradable plastic netting or twisted paper composition. The excelsior matting shall have a wood fiber minimum dry weight of 0.8 pound per square yard  $\pm$  5 %, and shall be of uniform thickness with the fiber evenly distributed over the entire area of the mat.  
The width of a single roll of matting and net shall be a minimum 36 inches, and the length of the roll shall be approximately 150 feet.
2. **Approval.** The Contractor shall submit to the Engineer for approval at least 10 Working Days in advance of proposed Material application, Manufacturer's Certificate of Compliance stating that the excelsior matting is environmentally safe and acceptable. This submittal shall be accompanied by a sample at least 3 square feet in area.

**9-14.5(4) CLEAR AND BLACK PLASTIC COVERING**

**Quality.** Plastic covering shall meet the requirements of the NIST Voluntary Product Standard, PS 17-69, for polyethylene sheeting having a minimum thickness of 6 mil.

**9-14.5(5) STAKES FOR EROSION CONTROL MATTING**

1. **Materials.** Stakes may be wire staples, steel pins, steel spikes, or wooden stakes.
2. **Size.** Stakes for securing erosion control matting to earth surfaces shall be a minimum 12 inches in length, and shall have sufficient strength to withstand pounding the stakes into soil flush with the surface.

**9-14.6 PLANT MATERIALS****9-14.6(1) DEFINITIONS**

1. **Bareroot** plants are grown in the ground and harvested without soil or growing medium around their roots. Roots shall be protected in transit with moist media such as peat or sawdust
2. **Container** plants are grown in pots or flats that prevent root growth beyond the sides and bottom of the container.
3. **Balled and burlapped** plants are grown in the ground and harvested with soil around a core of undisturbed roots. This rootball is wrapped in burlap and tied or placed in a wire basket or other supportive structure.
4. **Live cuttings** or live stakes are freshly cut stems (sometimes roots) taken from live plant material without a previously developed root system. Cuttings produce clones that are (usually) nearly identical to the source plants. Source plants for cuttings shall be vigorous, disease-free specimens. Acceptable sources, lengths and diameters of cuttings shall be as specified on the Drawings or plant schedules.
5. **Rhizomes** are a prostrate or subterranean stem, usually rooting at the nodes and becoming erect at the apex. Rhizomes shall have a minimum of two growth points. Tubers shall be a thickened and short subterranean branch having numerous buds or eyes.
6. **Whips** are bareroot trees, generally unbranched, and are sized typically in 1-foot height increments ranging from 2 feet to 6 feet not including the root.
7. **Seedlings** are plants propagated from seeds. Seedlings of woody plants demonstrate variability in appearance, size

and other growth characteristics that are not acceptable in many landscape situations. Seedling variability is often desirable in native and low-maintenance landscapes where diversity may provide disease resistance.

#### 9-14.6(2) QUALITY

1. **Standards.** All plant Material furnished by the Contractor shall conform to the requirements of the current issue of "American Standard for Nursery Stock" (ANSI).
2. **Plant Health and Regulation.** All plant Material shall meet State and Federal requirements with respect to plant health and absence of diseases and insect infestation. Inspection certificates required by law shall accompany each shipment of plant Material and shall be filed with the Engineer prior to planting. All plant Material specified shall be first-class representatives of their normal species or varieties in healthy growing condition with normal well-developed branch system and vigorous root systems. They shall be free from disease and insect infestation, disfiguring knots, sun-scalds, abrasions of the bark, broken tops and torn roots.
3. **Approved sources.** All plants shall be nursery grown stock unless otherwise indicated in the Contract.
4. **Integrity.** Plants shall not have cuts over 3/4 inch diameter which are not satisfactorily callusing over. Leader shall be intact on each plant. Large plants cut back to meet specified sizes will not be accepted. Trees shall be self-supporting, with straight trunks and with single straight leaders. Trees having damaged or missing leader, multiple leaders, or "Y" crotches will be rejected.
5. **Acclimation.** Plants furnished in pots or other containers shall be acclimated to outside conditions and equal to field grown stock.
6. **Collected Plant Material.** Collected Plant Material (including cuttings) shall come from approved legal locations. Contractor is responsible for securing any required permits and permissions from property owners. Collected plant material shall conform in quality, size, and grade to standards for nursery stock and shall be listed along with source location (Section 1-06.1) for approval at least 5 Working Days in advance of digging by the Supplier or Contractor.
7. **Replacements.** Any plant Material that is to be replaced shall be of the same species, cultivar, and equal size to the specified plant Material.
8. **Ball and Burlap.** Root balls shall be solidly held together by a fibrous root system and shall be composed only of the soil in which the plant has been actually growing. Broken or "Made" balls will not be accepted. The ball shall be securely wrapped with non-treated jute burlap or other packing Material not injurious to the plant life. Root balls shall be free of weed or foreign plant growth.
9. **Containers.** Container grown plants shall be plants transplanted into a container and grown in that container sufficiently long for new fibrous roots to have developed so that the root mass retains its shape and holds together when removed from the container. Plant Material which is rootbound will be rejected. Container sizes for plant Material of a larger grade than provided for in the container grown specifications of the American Standard for Nursery Stock (ASNS) shall be determined by the volume of the root ball specified in the ASNS for the same size plant Material.
10. **Bare Root.** All bare root plant Materials shall have a heavy fibrous root system. All plants shall be dormant at the time of planting. Roots shall be protected from drying in transit by wrapping, and stored in moist media in a shaded location if not planted immediately upon receipt. Additional environmental controls may be required to prevent drying or breaking dormancy if plants must be scored more than 48 hours.
11. **Form.** Average height to spread proportions and branching shall be in accordance with the applicable sections, illustrations, and accompanying notes of the American Standard for Nursery Stock. Plants, which have suffered damage as the result of girdling of the roots, stem, or a major branch; have deformities of the stem or major branches; have a lack of symmetry; have dead or defoliated tops or branches; or have any defect, injury, or condition which renders the plant unsuitable for its intended use, will be rejected.
12. **Street Trees.** Trees intended for installation as street trees shall have been grown with sufficient spacing to allow for symmetrical branch development which reflects the natural characteristics of the species. Trunks shall not be noticeably imperfect in vertical alignment, and there shall be no "included bark" in the crotches between the trunk and side branches.

#### 9-14.6(3) HANDLING AND SHIPPING

**General.** Handling and shipping shall be done in a manner that is not detrimental to the plants. The root system of all plant Material shall not be permitted to dry out at any time.

1. **Acclimation.** To acclimate plant Materials to Northwest conditions, all plant Materials used on a Project shall be grown continuously outdoors north of the 42nd Latitude (Oregon-California Border) for 60 days prior to delivery.
2. **Packing and Shipping.** Plant Material shall be packed for shipment in accordance with prevailing practice for the type of plant being shipped, and shall be protected at all times against drying, sun, wind, heat, freezing, and similar detrimental conditions both during shipment and during related handling. When transported in closed vehicles, plants shall receive adequate ventilation. When transported in open vehicles, plants shall be protected by tarpaulins or other suitable cover Material.
3. **Ball and Burlap.**
  - a. **Handling Root Balls.** Balled and burlapped plants shall be handled by the ball of earth and not the plant. Unless otherwise specified in the Contract, plants may be supplied in suitable containers acceptable to the Engineer should the Contractor so desire.
  - b. **Removal of Fabric and Wire Cages.** Balled and burlapped trees shall, as a minimum, be installed with all wrapping material, wire cages, twine, burlap and other material reinforcement removed from the top 2/3 of

root ball. Unless deemed detrimental to the stability of the rootball and health of the tree all wrappings and support materials should be removed.

4. **Containers.** All container grown plants shall be handled only by the container.

#### 9-14.6(4) RECORDS.

1. **Shipping List.** The nursery shall furnish a notice of shipment in triplicate at the time of shipment of each carload or other lot of plant Material. The original copy shall be mailed to the Engineer, the second copy to the consignee and the third copy shall accompany the shipment to be furnished to the Engineer at the Project Site. The notice shall contain the following information:
  - a. Name of shipper.
  - b. Date of shipment.
  - c. Name of commodity (including all names as specified in the Contract).
  - d. Consignee and delivery point.
  - e. Owner Contract number.
  - f. Point from which shipped.
  - g. Quantity contained.
  - h. Manufacturer's Certificate of Compliance of grade (statement that Material conforms to the Specifications).
  - i. Size (height, runner length, caliper, etc. as required).
  - j. Statement of root pruning (date pruned and size of pruning).
  - k. Signature of shipper by authorized representative.
  - l. Growing history of plant.
2. **Tagging.** All plants shall have legible labels attached to each individual plant delivered as a separate unit or to each box, bundle, bale or container containing one or more plants. Plant Material with illegible or missing tags will be rejected by the Engineer.
  - a. **Content.** Labels shall give the necessary detailed information as to horticultural name, size, age, caliper or other data required to identify as conforming to Specifications.
  - b. **Placement.** When the label is attached to a bundle, box, container, etc., containing more than one plant, information on the label shall show the quantity together with the other required information. Exception: All trees, whether furnished singly or bundled, shall be individually tagged with names, size or caliper, etc., needed as shown above. Contractor may refer to State of Washington Department of Agriculture, Orders 1229 and 1230, Nursery Stock Standards, regarding labeling of plant Material.
  - c. **Patented and Trademarked Varieties.** All plants that are patented or trademarked shall have an individual tag on each plant.
  - d. **Field Tagged Specimens.** Plant Material tagged in the field (nursery) by the Landscape Architect shall be delivered with tags in place.

#### 9-14.6(5) INSPECTION

1. **Approval of Source.** The Contractor shall, as soon as practical, inform the Engineer as to the source of plant Materials for the Project (See Section 1-06.1).
2. **Delivery Notification.** The Contractor shall notify the Engineer not less than 48 hours in advance of delivery of plants from the nursery to allow inspection at the nursery before delivery.
3. **Pre-Planting Inspection.**
  - a. **Trees.** All trees will be inspected by the Engineer at the Project Site prior to planting. Plants not meeting the requirements herein specified shall be immediately removed from the Project and replaced by the Contractor at the Contractor's sole expense.
  - b. **Container Stock.** Root condition of plants furnished in containers shall be determined by removal of the plant from the container. Plants not fully rooted through media to create an intact rootball, and rootbound plants with circling roots, shall be removed from the project site and replaced with acceptable specimens of the same variety.
  - c. **Timing.** Plant Material delivered, inspected and approved for planting shall be planted immediately. Plants not immediately planted by the Contractor may be temporarily stored after receiving approval from the Engineer (see Section 9-14.6(7)).

#### 9-14.6(6) SUBSTITUTION OF PLANTS

No substitution of plant Material, species or variety, will be permitted unless evidence is submitted in writing to the Engineer that a specified plant cannot be obtained and has been unobtainable since the Award of the Contract. Substitution can be made only with written approval by the Engineer in accordance with Section 1-05.3(6). The nearest variety, size, and grade as approved by the Engineer shall then be furnished.

#### 9-14.6(7) TEMPORARY STORAGE

1. **Storage Methods.** Plant Material delivered and accepted shall be planted immediately. Plants that cannot be planted within 1 Day after arrival shall be "heeled-in" in accordance with accepted horticultural practice, as follows:
  - a. **Bare Root.** Bare root plants shall be placed in trenches with roots covered with moist earth, sawdust or other acceptable material and be kept moist. All bare root Material supplied in bundles shall have the bundle broken and the plants placed in the trenches separately.

- b. **Ball and Burlap.** Balled and burlapped plants shall have the root ball protected by earth, sawdust, or other material acceptable to the Engineer and the material shall be kept continuously moist.
  - c. **Cuttings.** Live cuttings may be stored for up to seven Days, provided they are protected against loss of moisture by a minimum six inch thick layer of earth, sawdust, or other acceptable material and be kept moist. Adequate ventilation with an ambient temperature maintained at or near 40°F shall be provided above the cuttings to prevent fungus growth. Cuttings taken in November, December or January may be stored if wrapped to produce an airtight condition with temperature maintained between 33°F and 40°F.
- 2. **Responsibility for Stored Plants.** Plants stored under temporary conditions shall be the responsibility of the Contractor.
  - 3. **Protection.** Plants stored in any location for use on the Project shall be protected at all times from extreme weather conditions by insulating the root balls with sawdust, soil, or other approved Material and by keeping the roots moist at all times.

#### 9-14.6(8) SOD

- 1. **Quality.** Sod shall be mature, densely rooted grass; free of weeds and objectionable grasses. All sod shall comply with State and Federal law, including guaranty, with respect to inspection, plant diseases and insect infestation. Sod shall be cut to a 1 inch mowing height prior to lifting from the field.
- 2. **Netting.** Plastic netting is not allowed. If netting is required, it shall be biodegradable.
- 3. **Source.** Sod shall be grown in Western Washington or Oregon. Sod shipments shall have a certificate of origin and certification of approved treatment when shipment originates in known infected areas.
- 4. **Varieties.** Turf varieties should include only those ranked "Best" by the 2011 or most current succeeding year's WSU "Turfgrass Cultivars Evaluated In Western Washington/Oregon In Recent Years" list. ([Puyallup.wsu.edu/turf](http://Puyallup.wsu.edu/turf)). Alternative varieties may be substituted only if evidence is provided by Contractor that sod made up of these varieties is not available from local sources.
- 5. **Turf Types.** Turf type shall be determined by the Engineer, depending on the intended turf use:
  - a. High Performance – 100% perennial rye. Three or more varieties from approved list.
  - b. Ornamental and Passive Recreation. Three or more varieties from approved list, in a mix meeting the following proportions:

Turf-type perennial rye grass	>50%
Kentucky bluegrass	<30%
Fine fescue	>20%

#### 9-14.7 TREE STAKES, GUYS, AND WRAPPING

- 1. **Stakes.**
  - a. **Standard.** Stakes shall be 8 foot long 2 inch diameter pressure-treated lodgepole pine wood stakes, with chamfered tops and 6 inch long conical points (see Standard Plan no. 100a).
  - b. **Alternative for Grates.** The Contractor shall be prepared to provide No. 5 deformed steel reinforcing bar as a substitute stake for compatibility with tree grates.
  - c. **Installation.** The stakes shall be installed as shown in the Standard Plans unless the Contract indicates otherwise.
- 2. **Guys.**
  - a. **Material.** Guys shall be pre-manufactured adjustable ties made of plastic Material such as No. 2 Chainlock or approved equal.
  - b. **Installation.** The guys shall be installed as shown in the Standard Plans unless the Contract indicates otherwise.
  - c. **Adjustment and Removal.** Guys shall be adjusted at the end of the first growing season to prevent constriction of growth, bark ringing, or other conditions detrimental to optimal growth of the trees. Guys shall be removed one year after planting, except when noted otherwise in the Contract.
- 3. **Wrap.** Tree wrap shall be as indicated in the Contract.

#### 9-14.8 SHEAR BOARDS

Shear boards shall be 2 inch x 8 inch x 8 foot non-treated, rough finished lumber. When conditions require a length less than 8 feet, the Contractor shall plan the layout so that no individual length of cut shear board is less than 4 feet.

#### 9-14.9 PAVER BLOCKS AND INTERLOCKING CONCRETE PAVERS

##### 9-14.9(1) PAVER BLOCKS

- 1. **Material.** Paver blocks shall be exposed aggregate concrete of the size indicated on the Drawings. Pavers shall be made from the following mix:

Material	Quantity per cubic yard
gray cement	564 pounds
5/8 inch minus gravel	2,400 pounds
building sand	1,030 pounds

A sample of exposed aggregate showing the desired amount of exposure is available at the Seattle Public Utilities' Materials Laboratory at 707 South Plummer Street.

2. **Sealant.** Exposed aggregate surface of all concrete paver units shall be sealed with a heavy-duty concrete enamel containing a 10% methylacrylate solution or approved equal. On request by the Engineer, the Contractor shall provide a 1 pint sample of sealant for testing. Sealant Material shall be approved by the Engineer prior to application.
3. **Submittal.** The Contractor shall submit two sample paver blocks, which are representative of those to be used in the Project, for the Engineer's approval.

#### 9-14.9(2) INTERLOCKING CONCRETE PAVERS

1. **Quality.** The manufactured product shall meet the following Specifications in color, materials, physical properties configuration, and tolerances:
  - a. **Color.** The color of the unit concrete paver shall be natural conforming to samples available from the Engineer.
  - b. **Dimensions.** The nominal dimensions shall be:

length	9 inches
width	4-1/2 inches
thickness	2-3/8 inches

c. **Shape.**

- i. The length sides of the paver shall have two projections and two recessions per side. The projection on one side shall correspond to a recession on the opposite side. The projections and recessions shall be 3/8 inch when measured from the extension of the nominal width lines for the length of the paver.
- ii. The width sides of the paver shall have one projection and one recession per side. The projection on one side shall correspond to a recession on the other side. The projections and recessions shall be 3/8 inch when measured from the extension of the nominal length lines for the width of the paver.
- iii. The top and bottom surfaces shall be flat and parallel. The top side edge shall be chamfered 1/4 inch. The sides shall be perpendicular to the top and bottom surfaces. Full size edging pavers shall have one width side flat. Half size edging pavers shall be 1/2 the nominal length with one width side flat.
- iv. Length or width of paver unit shall not differ by more than 0.059 inches and heights shall not differ by more than 0.11 inches from the specified dimensions.

#### 9-14.9(3) CEMENTITIOUS MATERIALS

Materials shall conform to the following:

Material	Standard
Portland Cement	ASTM C 150
Blended Cement	ASTM C 595, Type 1S or 1P
Hydrated Lime	ASTM C 207, Type S
Pozzolan	ASTM C 618

#### 9-14.9(4) AGGREGATES AND OTHER CONSTITUENTS

Aggregates shall conform to the following, except that grading requirements may not necessarily apply:

Normal weight	ASTM C 33, for Concrete Aggregates
Lightweight	ASTM C 331, for Lightweight Aggregates for Concrete Masonry Units

Air-entraining agents, color pigments, integral water repellents, finely ground silica, etc., shall be previously established as suitable by the Engineer for use in concrete, and shall conform to ASTM Standards where applicable, or shall be shown by test or experience not be detrimental to concrete.

**9-14.9(5) PHYSICAL REQUIREMENTS**

1. **Compressive Strength.** At the time of delivery to the Project Site, the average compressive strength of test samples shall not be less than 8000 psi with no individual paver unit less than 7200 psi.
2. **Absorption.** The average absorption shall not be greater than 5%, with no individual unit greater than 7%.
3. **Freeze – Thaw.** The manufacturer shall satisfy the Owner by proven field performance of the laboratory freeze-thaw test that the paving units have adequate durability when subject to a freeze-thaw environment. See freeze thaw test in this Section.
4. Acceptable field performance is achieved when units similar in composition and produced by the same manufacturing process exhibit no objectionable deterioration for at least 3 years. The paver units used as the basis for proven field performance shall have been exposed to the same general type of environment, temperature, range, and traffic volume.
5. **Breakage.** When tested in accordance with Section 8 of ASTM C 67, specimens shall not have breakage or, greater than 1.0% loss on dry weight of any individual paver unit when subjected to 50 cycles of freezing and thawing. This test shall be conducted not more than 12 months prior to delivery of units. When tested in accordance with ASTM C 418. "Abrasion Resistance of Concrete By Sandblasting" specimens shall not have volume loss greater than 0.915 cubic inch per 7.75 square inch. The average thickness loss shall not exceed 1/8 inch.

**9-14.9(6) PERMISSIBLE TOLERANCE IN DIMENSIONS**

Length or width of paver unit shall not differ by more than 0.059 inches and heights shall not differ by more than 0.11 inches from the specified dimensions.

**9-14.9(7) VISUAL INSPECTION**

All paver units shall be sounded and free of defects that would interfere with the proper placing of unit; or impair the strength of the construction. Minor cracks or chips due to the usual method of manufacture and customary method of handling in shipment and delivery may be allowed subject to the discretion of the Engineer. Paver units identified as unacceptable by the Engineer shall be replaced.

**9-14.9(8) SAMPLING AND TESTING**

The Contractor shall submit three (3) samples of the paver unit to the SPU Material Laboratory for approval. Sample units will be tested in accordance with ASTM C 140.

**9-14.9(9) BASE COURSE**

The base course shall be 6 inches in depth, shall conform to the requirements of Section 9-03.9(3) Crushed Surfacing, and shall consist of Mineral Aggregate Type 2, 1-1/4 inch minus crushed rock, as describe in Section 9-03. 20% "ISOLITE" CG2 shall be incorporated into the base course in paver areas extending the width of the sidewalk adjacent to tree pits (a 8' x 7" surface area per pit).

**9-14.9(10) TOP COURSE OR KEYSTONE**

The Top Course shall be 2 inch in depth and shall conform to the requirements of Section 9-03.9(3) Crushed Surfacing and shall consist of Mineral Aggregate Type 1, 5/8" inch minus crushed rock, as describe in Section 9-03. 20% "ISOLITE" CG2 shall be incorporated into the base course in paver in areas extending the width of the sidewalk adjacent to tree pits (an 8' x 7" surface area per pit).

**9-14.9(11) LEVELING COURSE**

The Leveling Course shall conform to the requirements of Section 9-03.11 Crushed Gravel, as modified herein. The Material shall be 3/8 inch minus chip rock with the following gradation:

Sieve Size	% Passing
3/8 inch	98
1/4 inch	50 – 90
No. 4	25 – 55
No. 6	0 – 20
No. 10	0 – 10
No. 40	0 – 5
No. 200	0 – 3

Material passing the No. 200 sieve size shall be brought to the Project Site bagged and dry.

**9-14.9(12) BEDDING SAND**

The Bedding Sand shall conform to the requirements of Section 9-03.12(6) Washed Sand and Gravel and shall consist of Mineral Aggregate Type 6, washed sand, as described in Section 9-03.

**9-14.9(13) JOINT FILLING SAND**

The joint filling sand shall have the following grading:



Sieve Size	% Passing
US No. 8	95 - 100
US No. 16	60 - 70
US No. 30	15 - 25
US No. 50	0 - 5
US No. 100	0 - 2
US No. 200	0 - 1

The fracture shall be 100%. This Material is crushed sand.

#### **9-14.9(14) EDGING**

Edging shall be installed to separate all unit paver installations from adjacent planting or turf areas. Product shall be specified on Drawings and approved by Engineer.

#### **9-14.10 TURF REINFORCEMENT**

Turf reinforcement product shall be as specified on the Drawings and approved by Engineer.

#### **9-14.11 CEDAR EDGING**

Material for edging shall be 2 inch x 4 inch cedar, construction grade or better with tight knots.

#### **9-14.12 BOLLARDS**

##### **9-14.12(1) WOOD BOLLARDS**

Bollards shall be nominal 8 inch x 8 inch, 90 Day stack dry, select Douglas Fir. Bollards shall be pressure-treated (by closed cylinder method) with Pentachlorophenol after cutting and predrilling. Tops and four sides of bollards shall be painted (above the notch) with 2 coats of white marine enamel as manufactured by Inter-Lux or approved equal applied per manufacturer's recommendations.

All metal parts (bolts, nuts, washers, etc.) shall be hot-dipped galvanized.

##### **9-14.12(2) CONCRETE BOLLARDS**

Concrete bollards shall be made of Class 3000 cement concrete (see Section 6-02), reinforced with four No. 4 deformed steel bars placed one inch clear below the concrete surface and held in place with No. 8 gauge wire ties. After forms are removed, concrete shall show a smooth dense face. Any surface irregularities showing above grade shall be scraped or stoned off; the surface shall then be washed and a 1:1 mortar shall be brushed on. After the initial set but before the final set, the excess mortar shall be rubbed off using burlap sacking or pieces of carpeting. The bollards shall then be cured by being kept damp with water for not less than 2 Days.

##### **9-14.12(3) RESERVED**

##### **9-14.12(4) PADLOCKS FOR REMOVABLE BOLLARDS**

The padlock shall be as manufactured by Best Lock Company, Lock number 2B672 with bronze body, 2 inch stainless steel shackle, and equipped with construction core or approved equal.

#### **9-14.13 BENCHES**

Benches shall be of the type indicated in the Contract.

#### **9-14.14 TREE GRATES**

1. **Metal Tree Grates.** Tree grates shall be manufactured in 2 equal sized sections made of gray iron conforming to ASTM A 536, GR80-56-06. Grates shall have a 3/4 inch nominal thickness and cover an area not less than 24 square feet. To accommodate tree growth, the grates shall have 3 or 4 centrally located concentric break-out rings allowing a 12 inch minimum to 30 inch maximum opening in diameter. Break out rings shall have no more than 6 points of attachment per grate section and shall be scored to allow ease of expansion for tree growth. Grates shall be designed to not fail under a wheel load of up to 4000 pounds except at the break-out rings.
2. **Alternatives.** Alternative material use in the design and manufacturing of tree grates is subject to approval by the Engineer based on a submittal provided by the Contractor providing data on performance standards adequate to meet the public safety, sustainability, functional, and visual objectives of the project. Submittals shall include documentation of product use and performance over a minimum of 3 years on installations for public use in areas with comparable climactic conditions typical in the Pacific Northwest.

#### **9-14.15 IN-STREAM LOGS**

1. **Form.** In-stream logs shall consist of tree shoot with or without limb, and tree root and rootwad. In-stream log may include the use of on-site tree identified for removal. The shoot portion of the tree shall not contain any root and may have any alignment unless the Contract specifies otherwise. The logs shall not be limbed; however, may require trimming of limbs to dimensions as specified in the Contract.
2. **Species.** In-stream log shall be cedar, Douglas fir, or other species tree as specified in the Contract.
3. **Quality.** Logs shall be of sound quality, shall not be split or cracked, and shall be clean and free of insects, rot, decay, soil, rock, and other deleterious material.

4. **Dimensions.** The Contract will specify log length(s) and diameter(s), and may specify a range of butt and tip diameters. The root section dimension will contain a minimum and/or maximum diameter and may require trimming approximating a plane.

#### **9-14.16 WATTLES OR COMPOST SOCKS**

Wattles shall act as a screen or filter and shall consist of biodegradable plant material such as any combination of twigs, wicker, bamboo, other withes, straw, coir, and wood shavings, or for Compost Socks, in the shape of cylinders typically ranging from 8 inch to 16 inch diameter and of any length. The wattle shall be encased within biodegradable netting. Where not otherwise specified, Compost Socks shall be used.

#### **9-14.16 WATTLES**

Wattles shall act as a screen or filter and shall consist of biodegradable plant material such as any combination of twigs, wicker, bamboo, other withes, straw, coir, and wood shavings in the shape of cylinders typically ranging from 10 inch to 16 inch diameter and of any length. The wattle shall be encased within biodegradable netting.

#### **9-14.17 VERTICAL ROOT BARRIER.**

Root barriers shall be an injection molded or extruded modular component made of high density polypropylene or polyethylene plastic with a minimum of 30% recycled materials. Panels shall have a minimum thickness of 0.080" (2 mm). Each panel shall have molded vertical ribs (four minimum) and locking strips, integral male/female sliding locks, intergraded zipper joining system. Vertical root-deflecting ribs or channels shall be between 1/2-inch (12.7 mm) and 0.008" (0.2 mm) high, perpendicular to the panel, and between 5.91-inches (150 mm) to 7.87-inches (200 mm) apart. Panels shall be a minimum of 24-inches wide by 18 or 24-inches deep, or as shown on Drawings. The Contractor shall submit for approval a catalogue cut for the material and installation.

### **SECTION 9-15 IRRIGATION SYSTEM**

#### **9-15.1 PIPE AND FITTINGS**

##### **9-15.1(1) GENERAL**

Pipe shall be galvanized iron, PVC, or polyethylene, as specified in the Contract.

##### **9-15.1(2) GALVANIZED PIPE AND FITTINGS**

Pipe shall be standard weight, hot-dipped galvanized iron or steel pipe, threaded and coupled. Pipe shall meet the requirements of ASTM A 120.

##### **9-15.1(3) POLYVINYL CHLORIDE PIPE AND FITTINGS**

PVC pipe upstream of the control valves shall be schedule 40 and conform to all requirements of ASTM D 1785.

PVC pipe downstream of the control valves shall be pressure rated for 200 psi and conform to all requirements of ASTM D 2241, SDR 21.

Fittings shall be of the solvent weld type except where risers, valves, etc., require threaded transition fittings. Fittings shall conform to the requirements of ASTM D 2466.

PVC pipe and fittings shall be non-toxic, free from taste and odor, and self-extinguishing.

Pipe shall be homogenous throughout and free of defects cracks, holes, foreign Materials, wrinkles, dents and blisters.

PVC pipe shall be continuously and permanently marked with the following information: manufacturer's name, kind of pipe, National Sanitation Foundation (NSF) approval and schedule number.

##### **9-15.1(4) POLYETHYLENE PIPE**

Polyethylene pipe shall be Class 80, SDR 15, medium density polyethylene pipe, meet the requirements of ASTM D 2239, conform to U.S. Commercial Standard CS-255, and be National Sanitation Foundation (NSF) approved.

#### **9-15.2 CONTROL TUBING**

Control tubing shall be copper refrigerator tubing meeting the current requirements of ASTM B 280 in the size specified on the Drawings. Tubing and fittings shall be capable of withstanding a 300 psi operating pressure, and shall be of the size indicated on the Drawings.

#### **9-15.3 SLEEVE**

Pipe sleeves shall be PVC schedule 40. Sizes and installation shall be in accordance with the Drawings and Standard Plan no. 128.

Conduit shall meet the requirements of Section 9-34.

#### **9-15.4 IRRIGATION AUTOMATIC CONTROLLERS**

Automatic controllers shall be installed in electrical controller cabinets on a concrete base as shown on Standard Plan no. 129. The dimensions and details of the controller cabinet shall be as shown on Standard Plan no. 129 unless otherwise dimensioned and detailed in the Contract. A manufacturer of acceptable irrigation controller cabinets is Skyline Electric and Manufacturing Co., Seattle, Washington.

The controller shall be an electrically timed device for automatically opening and closing control valves for predetermined periods of time and mounted so that all normal adjustments are conveniently located for use by the operator. Controllers shall be enclosed in a weatherproof metal enclosure. The Contractor shall submit a Shop Drawing of the padlock secured enclosure sized adequately to hold all specified equipment. The enclosure shall include a modified free-standing shelf measuring 12 inches x 12 inches x 15 inches high to hold the Controller, and one GFCI outlet with 15 amp circuit breaker (10,000 amp AIC) located in the upper right hand corner. All 120 volt wiring shall be behind a dead front panel. The controller shall be solid state and capable of operating the irrigation system as designed and constructed and shall include the following operating features:

1. Each controller station shall be adjustable for setting to remain open for any desired period of time - from five minutes or less to at least one hour.
2. Adjustments shall be provided whereby any number of Days may be omitted and whereby any one or more positions on the controller can be skipped. When adjustments are made, they shall continue automatically within a 14 Day cycle until the operator desires to make new adjustments.
3. Controls shall allow any position to be operated manually both on or off whenever desired.
4. Controls shall provide for resetting the start of the irrigation cycle at any time and advancing from one position to another.
5. Controllers shall contain an on-off switch and fuse assembly.
6. Controller adjustments shall be such that the open cycle may be doubled or repeated not less than 3 times during the complete watering cycle.
7. Controller shall have a power failure cutout.
8. Controller shall be UL approved and marked accordingly.

Contractor shall provide an outdoor rated padlock by Best Manufacturing Company with a removable blue core.

#### **9-15.5 SPRINKLER HEADS**

Sprinkler heads shall be of the type, pattern, and coverage shown on the Drawings at rated operating pressure specified, discharging not more than the amount of gallons per minute specified.

Sprinkler heads shall be designed so that spray adjustments can be made by either an adjustment screw or interchangeable nozzles. Watering cores shall be easily removed without removing the housing from the pipe.

All turn heads shall be designed with turf flanges having 2 gripping holes to facilitate removal of the head.

When the Contract does not specify irrigation system spacing, or does not specify irrigation head make or model, then the Contractor shall submit the missing information to the Engineer for approval at least 10 Working Days in advance of ordering Materials. Approval, and request for approval of substitution, of sprinkler heads will be based on compatibility of Materials with other Owner systems at the Project Site (see Sections 1-02.4(1) and 1-05.3(6)). The Contractor shall design the layout of such systems incorporating efficient and adequate coverage without overspray.

#### **9-15.6 ELECTRICAL WIRE**

Wire from controller to valves shall be #14 UF direct burial (UL approved), red or black for the hot side, white for neutral (solid copper). The auxiliary wires, where required, shall be any third color (except green). UF and UL designations shall be clearly marked on the insulation jacket of all wires.

#### **9-15.7 IRRIGATION VALVES**

##### **9-15.7(1) GATE VALVES**

Gate valves, when called for on the Drawings, shall be heavy duty bronze conforming to the requirements of ASTM B 62. Valves shall be of the same size as the pipes on which they are placed and shall have union or flange connections. Service rating (for non-shock cold water) shall be 300 psi. Valves shall be of the double disk, taper seat type, with rising stem, union bonnet and handwheel. Manufacturer's name, type of valve and size shall be cast on the valve.

##### **9-15.7(2) CONTROL VALVES**

##### **9-15.7(2)A MANUAL CONTROL VALVES**

Manual valves shall be bronze or brass, angle type with hex brass union. Service rating shall be not less than 150 psi nonshock cold water. Valves shall be designed for underground installation with suitable cross wheel for operation with a standard key. The Contractor shall furnish three suitable operating keys per Contract. Valves shall have removable bonnet and stem assembly with adjustable packing gland and shall house long acme threaded stem to ensure full opening and closing. Valve discs shall be full floating with replaceable seat washers.

##### **9-15.7(2)B AUTOMATIC CONTROL VALVES**

Automatic remote control valves shall be globe pattern with flanged or screwed connections as required. The valve shall be constructed so as to allow all internal parts to be removable from the top of the valve without disturbing the valve installation. Screwed valves shall be provided with union connections.

Valves shall be of a "normally closed" design and shall be electric solenoid operated, having maximum rating of 6.5 watts utilizing 24 volts AC power. Solenoids shall be directly attached to the valve bonnets or body with all control parts and ports completely internal. Valves shall be of 150 psi brass or bronze, or iron body bronze-mounted combination. The time interval for valve closing operation shall be a minimum of 5 seconds for complete closure at constant rate of closing and a minimum of 3 seconds to completely open at a constant rate of opening. A manual control bleed cock shall be included on the valve to operate the valve without electric current. A manual shutoff stem with cross handle for wrench operation is required

for manual adjustment from fully closed to wide open. Once the manual adjustment is set, the valve can be operated automatically in the adjusted position. Water flow shall be completely stopped when the control valve is closed either manually or automatically. Automatic control valves and automatic controllers need not be of the same manufacturer.

All automatic control valves shall be pressure reducing valves unless otherwise specified in the Contract.

#### **9-15.7(2)C AUTOMATIC CONTROL VALVES WITH PRESSURE REGULATOR**

The automatic control valve with pressure regulator shall be similar to the automatic control valve and shall also reduce the inlet pressure to a constant lower pressure regardless of supply fluctuations. The regulator shall be fully adjustable.

#### **9-15.7(3) QUICK COUPLER VALVES**

Quick coupler valves shall have a service rating not less than 125 psi for nonshock cold water. The body of the valves shall be of cast leaded semi-red brass alloy No. C84400 conforming to ASTM B 584. The base of the valve shall have standard female pipe threads. The design of the valve shall be such that it opens only upon inserting a coupler key and closes as the coupler is removed from the valve. Leakage of water between the coupler and valve body when in operation will not be accepted. The valve body receiving the coupler shall be designed with double worm slots to allow smooth action in opening and closing of the valve with a minimum of effort. Slots shall be notched at the base to hold the coupler firmly in the open position. Couplers shall be of the same material as the valve body with stainless steel double guide lugs to fit the worm slots. Couplers shall be of one piece construction with steel reinforced side handles attached. All couplers shall have standard male pipe threads at the top. Couplers shall be furnished with all quick coupler valves unless otherwise specified in Contract. See Standard Plan no. 121.

#### **9-15.7(4) DRAIN VALVES**

The Contractor shall install a 3/4 inch male automatic ball check drain valve at the low point in the system. The drain valve shall be drained to a pocket containing a minimum of 1/2 cubic yard of Mineral Aggregate Type 4. See Standard Plan no. 122.

#### **9-15.7(5) CHECK VALVES**

Check valves shall be heavy duty bronze or steel. The valves shall function by means of a hinged disc suspended from the body and able to close of its own weight. Valves shall be of the size as the pipes on which they are placed, unless otherwise specified in the Contract, and shall have union or flanged connections. Service rating (for non-shock cold water) shall be 300 psi. Manufacturer's name, type of valve and size shall be cast on the valve.

#### **9-15.7(6) PRESSURE REDUCING VALVES**

Pressure reducing valves shall have a minimum of 150 psi working pressure with an adjustable outlet range of 20 to 70 psi. The valves shall be factory set as shown on the Drawings.

Pressure reducing valves shall be rated for safe operation at 175 psi non-shock cold water.

#### **9-15.7(7) THREE WAY VALVES**

Three way valves shall be tight closing, three port, ball or plug type, constructed to permit straight through and 90 degree flow only. The valve shall be of bronze or approved corrosion resistant body Materials and shall have a minimum of 150 psi working pressure. The head of the valve, or handle when applicable, shall be permanently marked to indicate port position. Whenever handles are included as an integral part of the valve, the Contractor shall remove the handles and give them to the Engineer for ultimate distribution to the Maintenance Division.

#### **9-15.7(8) FLOW CONTROL VALVES**

Valve body materials shall be plastic or metal. Internal parts shall be stainless steel. Valves shall be factory set to design flows. Valves shall have no external adjustment and be tamper proof when installed. One-quarter inch and smaller flow control valves shall have a minimum pressure absorption range of 2 to 32 psi. One and one half inch and larger flow control valves shall have a minimum pressure absorption range of 3 to 50 psi.

Flow shall be controlled to 5 percent of design volumes.

#### **9-15.7(9) AIR RELIEF VALVE**

The air relief valve shall automatically relieve air and break a vacuum in the serviced pipe. Body Materials shall be installed exactly at all high points.

#### **9-15.8 VALVE BOXES**

All automatic control valves, flow control valves, and pressure reducing valves shall be provided with valve boxes. Valve boxes shall be sized as appropriate to allow efficient access to components and shall be approved by the Engineer prior to installation. Valve boxes shall be extendable to obtain the depth required. Where 1 inch diameter Schedule 80 PVC braces are required for quick coupler valves as indicated on Standard Plan no. 121, the box shall have holes adequately sized to securely snug fit the brace. All manual drain valves and manual control valves shall be equipped with a protective sleeve and cap as shown in the Standard Plans.

#### **9-15.9 BACKFLOW PREVENTION ASSEMBLIES**

Backflow prevention assemblies shall be as specified in Section 9-30.16.

**9-15.10 HOSE BIBS**

Hose bibs shall be constructed of bronze or brass, angle type threaded to accommodate a 3/4 inch hose connection, and shall be key operated. Design shall be such as to prevent operation by wrench or pliers.

**9-15.11 DETECTABLE MARKING TAPE**

Detectable marking tape shall consist of inert polyethylene plastic that is impervious to all known alkalis, acids, chemical reagents, and solvents likely to be encountered in the soil, with a metallic foil core to provide the most positive detection and pipeline locators.

The tape shall be color coded and shall be imprinted continuously over its entire length in permanent black ink. The message shall convey the type of line buried below and shall also have the word "Caution" prominently shown. Color coding of the tape shall be as follows:

UTILITY	TAPE COLOR
Water	Blue
Sewer	Green
Electrical	Red
Gas-Oil	Yellow
Telephone-CATV	Orange
Non-Potable Water	Purple

The width of the tape shall be as recommended by the manufacture for the depth of installation.

**SECTION 9-16 FENCE AND GUARDRAIL****9-16.1 CHAIN LINK FENCE AND GATES****9-16.1(1) GENERAL**

All Material used in the construction of chain link fence and gates shall be new. Iron or steel Material shall be galvanized; however, exceptions to galvanizing are listed in various Standard Plans and other Standard Specifications. Imperfectly galvanized Material or Material upon which serious abrasions of galvanizing occur will not be acceptable.

The base Material for the manufacture of steel pipes used for posts, braces, top rails, and gate frames shall conform to the requirements of ASTM F 1083. The base Material for the manufacture of steel H columns shall meet the requirements of ASTM A 663 or ASTM A 675.

Roll-formed posts, braces, and rails shall be made from sheet steel and shall conform with the details as shown on the Drawings or Standard Plan no. 450b. The Material for end, corner, and pull posts shall have a minimum yield strength of 35,000 psi. The minimum yield strength for Alternate A roll-formed line posts shall be 40,000 psi and for Alternate B roll-formed line posts 45,000 psi. Top rail and braces to be used with Alternate A or B line posts shall conform to the minimum yield strength as required for either post respectively.

All posts, braces, top rails, and gate frames shall be hot-dip galvanized. They shall have a minimum average of 1.8 ounces zinc coating per square foot of surface area with no individual test being below 1.6 ounces zinc coating per square foot of surface area. In the case of members made from pipe, this area is defined as the total area inside and outside. A sample for computing the average weight of coating is defined as a 12 inch piece cut from each end of the galvanized member. Fittings shall be galvanized in accordance with the requirements of ASTM F 626. Other Materials shall be galvanized in accordance with the requirements of ASTM A 153.

**9-16.1(2) POSTS**

All posts for chain link fence shall be of the shape, size, and weight per foot shown on Standard Plan no. 450b. Roll-formed end, corner, and pull posts shall be made from 0.1345 inch minimum thickness sheet steel and shall have integral fastening loops to connect to the fabric for the full length of each post. Roll-formed line posts shall be made from 0.110 inch minimum thickness sheet steel for Type 3 and Type 4 fences and shall be made from 0.120 inch minimum thickness sheet steel for Type 1 and Type 6 fences.

An acceptance tolerance for posts for chain link fence allows for deviation from the weight per linear foot specified in the Standard Plans. This tolerance shall be applied on an individual post basis and shall be plus or minus 5 percent for tubular and H-section posts and plus or minus 6 percent for roll form sections. Materials that exceed the weight per foot or wall thickness Specification may be accepted, providing they do not interfere with the proper construction of the fence.

**9-16.1(3) TOP RAIL, BRACES, AND TRUSSES**

Top rail and compression braces shall be of the type and size shown on Standard Plan no. 450b. Tension truss rods shall be 3/8 inch round galvanized rods with drop forged turnbuckles, or other approved type of adjustment. Couplings for tubular sections shall be outside sleeve type and at least 6 inches long. Roll-formed top and brace rails shall be made from 0.0747 inch thick sheet steel and shall be an open rectangular section with internal flanges. The acceptable thickness tolerance for sheet steel members shall be  $\pm 0.006$  inch.

**9-16.1(4) TENSION WIRE AND ATTACHMENTS**

Top and bottom wire shall be 7 gage coil spring steel wire of good commercial quality and shall have a zinc coating averaging 0.8 ounce per square foot of surface area. All tension wire attachments shall be hot-dip galvanized steel. Eye bolts shall be 3/8 inch diameter and of sufficient length to fasten to the type of posts used.

**9-16.1(5) RESERVED****9-16.1(6) FITTINGS**

All fittings and miscellaneous hardware shall be malleable cast iron or pressed steel. Fittings shall be galvanized in accordance with ASTM F 626. Galvanizing of miscellaneous hardware not covered by ASTM F 626 shall be in conformance with ASTM A 153. Fittings for any particular fence shall be those furnished by the manufacturer of the fence.

**9-16.1(7) CHAIN LINK FENCE FABRIC**

Chain link fabric shall consist of 11 gage wire (0.120 inch diameter) for Types 3, 4, and 6 fence; and 9 gage wire (0.148 inch diameter) for Type 1 fence. The fabric wire may be one of the following Materials provided that only one type shall be selected for use in any one Contract:

1. Galvanized steel wire conforming to ASTM A 392.
2. Galvanizing shall be Class I performed by the hot-dip process.
3. Aluminum coated steel wire conforming to ASTM A 491.
4. Class II aluminum wire conforming to 6061-T94 alloy.

The wire shall be woven into approximately 2 inch diamond mesh. The width and top and bottom finish of the fabric shall be as shown in Standard Plan nos. 450a and 450c.

**9-16.1(8) FABRIC BANDS AND STRETCHER BARS**

Fabric bands shall be 1/8 inch by 1 inch nominal and stretcher bars 3/16 inch by 3/4 inch nominal. Nominal shall be construed to be the area of the cross-section of the shape obtained by multiplying the specified width by thickness. A variation of plus or minus 5 percent from this theoretical area shall be construed as "nominal" size. Both shall be hot-dip galvanized to meet the requirements of ASTM F 626.

**9-16.1(9) TIE WIRE**

Tie wire shall be 9 gage aluminum wire complying with the ASTM B 211 or 9 gage galvanized wire meeting the requirements of AASHTO M 279. Galvanizing shall be Class 1. Hog rings shall meet the requirements of AASHTO M 279. Galvanizing shall be Class 1.

**9-16.1(10) CHAIN LINK GATES**

Gate frames shall be constructed of not less than 1-1/2 inch inside diameter hot-dip galvanized pipe with nominal weight of 2.72 pounds per linear foot. The corners of the gate frame shall be fastened together and reinforced with a malleable iron or pressed steel fitting designed for the purpose, or they may be welded. Welding shall conform to the requirements of Section 6-03.3(25). All welds shall be ground smooth and painted with a high zinc dust content paint meeting the requirements of MIL-P-21035. The paint shall be applied in one or more coats to provide a dry film thickness of 3.5 mils minimum.

Cross trussing shall be 3/8 inch galvanized steel adjustable rods.

Chain link gate fence fabric Material shall be the same as used for the chain link fence (see Section 9-16.1(7)).

Each gate shall be furnished complete with necessary hinges, latch, and drop bar locking device designed for the type of gate posts and gate used on the Project. Gates shall have positive type latching devices with provisions for padlocking.

Gate frames constructed of steel sections, other than pipe, that are fabricated in such a manner as to form a gate of equal or better rigidity may be used provided they are approved by the Engineer.

**9-16.1(11) MISCELLANEOUS**

All concrete shall be Class 3000 as specified in Section 6-02.3.

**9-16.2 WIRE FENCE AND GATES****9-16.2(1) GENERAL**

All materials used in the construction of the wire fence shall be new. All iron or steel material shall be galvanized. Imperfectly galvanized material or material upon which serious abrasions of galvanizing occur shall not be used.

**9-16.2(2) STEEL FENCE POSTS AND BRACES**

All posts for chain link fence shall be of the shape, size, and weight per foot shown in Standard Plan no. 450b. Roll-formed end, corner, and pull posts shall be made from 0.1345 inch minimum thickness sheet steel and shall have integral fastening loops to connect to the fabric for the full length of each post. Roll-formed line posts shall be made from 0.110 inch minimum thickness sheet steel for Type 3 and Type 4 fences and shall be made from 0.120 inch minimum thickness sheet steel for Type 1 and Type 6 fences.

Line posts may be channel, T, U, Y, or other approved shape, manufactured solely for use as fence posts. One type of line post shall be used throughout the Project. Line posts shall be studded, slotted, or properly adapted for attaching either wire or mesh in a manner that does not damage the galvanizing of posts, wire, or mesh during the fastening. Line posts shall

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have a minimum weight of 1.33 pounds per linear foot and shall be provided with a tapered steel anchor plate attached securely having a minimum weight of 0.67 pounds and having a surface area of 20 square inches  $\pm$  2 square inches.

End, corner, gate, and pull posts shall meet the requirements specified for line posts, except that the posts shall have a minimum weight of 3.1 pounds per linear foot and anchor plates and special studs, slots, or adapters for the attachment of wires will not be required.

Braces shall have a minimum weight of 3.1 pounds per linear foot.

All posts, braces, anchor plates, and hardware not covered by ASTM F 626 shall be galvanized in accordance with the requirements of ASTM A 123, or ASTM A 153.

A tolerance of minus 5 percent on the weight of individual posts, braces, or anchor plates will be permitted.

#### **9-16.2(3) WOOD FENCE POSTS AND BRACES**

Douglas fir, Western red cedar, hemlock, or larch shall be used in the construction of wood fence posts and braces. The material shall be of good quality and approved by the Engineer before use. Peeler cores shall not be used for round posts. Wood fencing materials shall have sufficient sapwood in the outer periphery to obtain the specified penetration of preservative. Western red cedar will not require preservative treatment. Fencing materials shall be cut to the correct length before pressure treatment.

Line posts shall be 3-inch minimum diameter round posts or nominal 3-inch by 3-inch square sawed posts. If the posts are to be pointed for driving, they shall be pointed before treatment. Line posts shall be at least 7-feet in length.

Pull posts and brace posts shall be 6-inch diameter round posts or nominal 6-inch by 6-inch material not less than 7-feet in length.

End, gate, and corner posts, and posts at an intersecting fence shall be 6-inch diameter round posts or nominal 6-inch by 6-inch material not less than 7-feet 10-inches in length.

All sawed posts and timbers shall meet the requirements in the table under Section 9-09.2.

The preservatives used to pressure treat wood fencing materials shall meet the requirements of Section 9-09.3.

The retention and penetration of the preservative shall be as follows:

MINIMUM RETENTION IN POUNDS PER CUBIC FOOT		
PRESERVATIVE	SAWED POSTS	ROUND POSTS
ACA	0.40	0.40
ACZA	0.40	0.40

MINIMUM PENETRATION	
for material 5" or less	0.40-inches penetration and 90% of sapwood
for material 5" or greater	0.50-inches penetration and 90% of sapwood

#### **9-16.2(4) BRACE WIRE**

Brace wire shall be 9 gage galvanized wire meeting the requirements of ASTM A 116, galvanizing Class 3.

#### **9-16.2(5) STAPLES AND WIRE CLAMPS**

The staples used to attach the wire fencing to wood posts shall be galvanized 9 gage, 1-1/2 inches long meeting the requirements of AASHTO M 279, galvanizing Class 1.

The wire clamps used to attach the wire fencing to steel posts shall be galvanized 11 gage wire meeting the requirements of AASHTO M 279, galvanizing Class 1.

#### **9-16.2(6) BARBED WIRE**

Barbed wire shall conform to the requirements of AASHTO M 280, and shall consist of two strands of 12-1/2 gage wire, twisted with four point 14 gage barbs with the barbs spaced an average of 5 inches apart. Galvanizing shall be Class 3.

#### **9-16.2(7) WIRE MESH**

Wire mesh shall conform to the requirements of AASHTO M 279, and shall consist of seven horizontal wires with vertical stays spaced 6 inches apart. The top and bottom wires shall be 10 gage, and the intermediate wires and vertical stays shall be 12-1/2 gage. The mesh shall have a total width of 26 inches (Design No. 726-6-12-1/2). Galvanizing shall be Class 3. The zinc-coated wire as represented by the test specimens shall be capable of being wrapped in a close helix at a rate not exceeding 15 turns/minute around a cylindrical steel mandrel having a diameter the same as the specimen being tested, without cracking or flaking the zinc coating to such an extent that any zinc can be removed by rubbing with the bare fingers.

#### **9-16.2(8) VERTICAL CINCH STAYS**

Vertical cinch stays shall be 9-1/2 gage galvanized wire meeting the requirements of AASHTO M 279, except that the minimum weight of zinc coating shall be 0.3 ounce per square foot of uncoated wire surface.

#### **9-16.2(9) WIRE GATES**



Gate frames shall be constructed of galvanized standard weight pipe with a nominal diameter of not less than 1 inch. The pipe shall conform to the requirements of ASTM A 53. Wire gates shall be not less than 48 inches in height and shall be designed to fit openings of the widths called for in the Contract. Each gate shall be provided with two upright braces of the same material as the frame, spaced at 1/3 points in the gate. All gates shall be provided with adjustable 3/8 inch diameter diagonal truss rods from corner to corner.

The gate frame shall be provided with wire mesh conforming to the requirements specified in Section 9-16.2(7), except that it shall consist of 10 horizontal wires and have a total width of 47 inches (Design No. 1047-6-12-1/2).

Each gate shall be furnished complete with necessary hinges and latch designed for use with the type of gate posts used on the Project. The hinges shall be so designed as to be securely attached to the gate post and to enable the gate to be swung back against the fence.

Double gates shall be hinged in the same manner as single gates and shall be provided with an approved drop bar locking device.

#### **9-16.2(10) MISCELLANEOUS**

Bolts, nuts, and hinges used in the construction of fence and gates shall be galvanized in accordance with AASHTO M 232.

All concrete shall be Class 3000 in accordance with Section 6-02.3.

### **9-16.3 NON-WEATHERING STEEL BEAM GUARDRAIL**

#### **9-16.3(1) RAIL ELEMENT**

The W-beam or thrie beam rail elements, backup plates, reducer sections, and end sections shall conform to "A Guide to Standardized Highway Barrier Hardware" published by AASHTO, AGC, and ARTBA. All rail elements shall be formed from 12-gage steel except for thrie beam used for bridge rail retrofit and Design F end sections, that shall be formed from 10 gage steel.

The rail splices shall have a minimum total ultimate strength of 80,000 pounds at each joint.

The 6 inch channel rails and splice plates shall conform to ASTM A 36. All fabrication shall be complete before galvanizing.

The holes in the plate shall be slotted to facilitate erection and to permit expansion and contraction. The edges of the rail shall be rolled or rounded so they present no sharp edges. Where the rail is on a curve, the plates at the splice shall make contact throughout the area of splice. When the radius of curvature is less than 150 feet, the rail shall be shaped in the shop.

#### **9-16.3(2) POSTS AND BLOCKS**

Posts and blocks may be of ammoniacal copper arsenate (ACA), or ammoniacal copper zinc arsenate (ACZA), treated timber or galvanized steel; except only treated timber posts and blocks may be used for weathering steel beam guardrail. Blocks made from alternate materials that meet the NCHRP Report 350 criteria may be used in accordance with the manufacturer's recommendations. Except for terminal or anchor assemblies, all posts for any one project shall be of the same type (wood or steel). Posts and blocks shall be of the size and length shown in the Plans and meet the requirements of these Specifications. Posts and blocks may be S4S or rough sawn.

Timber posts and blocks shall conform to the grade specified in Section 9-09.2, except pine lumber No. 1 grade may be used for the blocks. Timber posts and blocks shall be fabricated as specified in the Plans before being treated. Timber posts and blocks shall be treated by the empty cell process to provide a minimum retention, depending on the treatment used, according to the following:

- ACA 0.50 lbs. pcf.
- ACZA 0.50 lbs. pcf.

Treatment shall be in accordance with Section 9-09.3.

Steel posts, blocks, and base plates, where used, shall conform to either ASTM A 36 or ASTM A 992, and shall be galvanized in accordance with AASHTO M 111. Welding shall conform to Section 6-03.3(25). All fabrication shall be completed prior to galvanizing.

#### **9-16.3(3) GALVANIZING**

Beam rail elements and terminal sections shall be galvanized in accordance with AASHTO M 180, Class A, Type 2, except that the rail shall be galvanized after fabrication, with fabrication to include forming, cutting, shearing, punching, drilling, bending, welding, and riveting. In addition, the minimum average weight of zinc coating shall be 2 ounces per square foot of surface (not sheet), the average to be determined on the basis of three individual tests, no one of which may be less than 1.8 ounces per square foot of surface (not sheet). The aluminum content of the zinc bath during actual galvanizing operations shall not exceed 0.01 percent. Channel rails, splice plates, WF steel posts, and base plates shall be galvanized in accordance with ASTM A 123. Anchor cables shall be galvanized in accordance with Federal Specification RR-W-410, Table II, galvanized at finished size. Bolts, nuts, washers, plates, rods, and other hardware shall be galvanized in accordance with ASTM A 153.

#### **9-16.3(4) HARDWARE**

Bolts, unless otherwise specified in other Standard Specifications or in the Standard Plans, shall comply with ASTM A 307, Grade A specifications. High strength bolts shall conform to the requirements of AASHTO M 164. Nuts shall comply

with ASTM A 563, Grade A specifications. Washers, unless otherwise specified in other Standard Specifications or in the Standard Plans, shall meet ASTM F 844 specifications. The Contractor shall submit a Manufacturer's Certificate of Compliance for the bolts, nuts, and washers prior to installing any of the hardware.

#### **9-16.3(5) ANCHORS**

Welding shall conform to Section 6-03.3(25).

All welding shall be at least equal in strength to the parent metal.

All fabrication shall be complete and ready for assembly before galvanizing. No punching, drilling, cutting, or welding will be permitted after galvanizing unless authorized by the Engineer.

Foundation tubes shall be fabricated from steel conforming to the requirements of ASTM A 500, Grade B, or ASTM A 501.

The anchor plate assembly shall develop a minimum tensile strength of 40,000 pounds.

The anchor plate, W200 x 27 and metal plates shall be fabricated of steel conforming to the specifications of ASTM A 36.

Anchor cable shall be ¾-inch preformed, 6 x 19 wire strand core or independent wire rope core (IWRC), galvanized, right regular lay manufactured of improved plow steel with a minimum breaking strength of 42,800 pounds. Two certified copies of mill test reports of the cable used shall be furnished to the Engineer.

Swaged cable fittings shall develop 100 percent of the specified breaking strength of the cable. One swaged fitting attached to 3 feet of cable shall be furnished to the Engineer for testing.

The swaged fitting and stud assembly shall be of steel conforming to the requirements of American Iron and Steel Institute C-1035 and shall be annealed and galvanized suitable for cold swaging.

Welded wire fabric for Type 1 anchor shall conform to ASTM A 185.

All metal components of the anchor and cable assembly and not less than the top 14 inches of the W8 x 17 for the Type 2 anchor shall be hot-dip galvanized in accordance with Section 9-16.3(3).

Cement concrete, of the class specified, shall conform to the applicable requirements of Section 6-02.3.

Cement grout shall consist of one part Portland cement and two parts sand.

#### **9-16.3(6) INSPECTION AND ACCEPTANCE**

The Contractor shall give at least 3 Working Days advance notice to the Engineer before the rail elements are fabricated in order that inspections may be provided. The Contractor shall arrange for all facilities necessary for the inspection of material and workmanship at the point of fabrication of the rail element, and Inspectors shall be allowed free access to necessary parts of the premises.

The Inspector shall have the authority to reject materials or workmanship which do not fulfill the requirements of these Specifications. In cases of dispute, the Contractor may appeal to the Engineer, whose decision will be final.

The Inspector may accept a mill test report certifying that the steel used in fabricating the rail element meets the requirements of the Specifications. The Owner reserves the right, however, to require the Contractor to furnish samples of the steel proposed for use and to determine to its satisfaction that the steel meets the Specification requirements. Steel rail elements, fittings, terminal section hardware, and bolts may be accepted by the Engineer based on the Manufacturer's Certification of Compliance.

#### **9-16.4 WIRE MESH SLOPE PROTECTION**

##### **9-16.4(1) GENERAL**

All metal material used in the construction of wire mesh slope protection shall be new and galvanized. Imperfectly galvanized material or material upon which serious abrasion of galvanizing occurs will not be acceptable.

##### **9-16.4(2) WIRE MESH**

The galvanized wire mesh shall consist of No. 9 gage (0.148 inch diameter) commercial quality zinc coated steel wire, 3-1/2 inches x 5-1/2 inches diamond mesh chain link conforming to the requirements of AASHTO M 181. Galvanizing shall conform to the requirements of ASTM A 392 except the weight of zinc coating shall be 0.80 ounce per square foot minimum, of uncoated wire surface. Galvanizing shall be done before weaving.

The wire mesh fabric shall have knuckled selvages.

Alternate wire mesh for slope protection shall be double twisted mesh. The mesh shall be of nonraveling construction and consist of a uniform double twisted hexagonal mesh of hot-dip galvanized steel wire having a diameter of 0.120 inch after galvanization. The wire shall be galvanized prior to weaving into the mesh and shall conform to ASTM A 641, Class 3, Finish 5, Soft temper. The minimum tensile strength shall be 60,000 psi when tested in accordance with ASTM A 370. Openings shall be hexagonal in shape and uniform in size measuring not more than 3-1/4 inches by 4 ½ inches, approximately 9 square inches. Lacing wire shall be the same specifications as the wire used in the wire mesh except that its diameter shall be 0.0866 inch after galvanization.

Edges shall be mechanically selvaged in such a manner as to prevent unraveling, and shall develop the full strength of the mesh. The wire used for the selvage shall have a nominal diameter of 0.1535 inch.

**9-16.4(3) WIRE ROPE**

Wire rope shall be 5/8 inch diameter zinc coated steel structural wire rope conforming to the requirements of ASTM A 603, Class A.

**9-16.4(4) HARDWARE**

All rings shall be drop-forged steel, heat treated after forging. Lightweight wire rope thimbles weighing approximately 13.8 pounds per hundred shall be used with the 1/2-inch diameter wire rope. Wire rope clips may be drop-forged steel or cast steel for use with 1/2-inch wire rope. All rings, thimbles, wire rope clips, and U-bolts shall be galvanized in accordance with AASHTO M 232, Class C, except castings shall be Class A, and forgings shall be Class B.

**9-16.4(5) HOG RINGS AND TIE WIRE**

Hog ring fasteners and tie wire shall be manufactured of 9 gauge steel wire meeting federal specification QQ-W-461 (AISI numbers 1010 and 1015) finish 5; medium hardness and tensile strength; Class 3 coating.

**9-16.4(6) GROUT**

When required, grout for anchors shall consist of one part Portland cement and three parts of clean sand. The Portland cement shall conform to the requirements of Section 9-01.2(1).

**9-16.4(7) ANCHOR RODS**

Anchor rods shall be of good quality steel. The eye may be drop forged or formed with a full penetration weld and shall develop 100 percent of the rod strength. The anchor rod shall be galvanized in accordance with ASTM A 153.

**9-16.5 RESERVED****9-16.6 GLARE SCREEN****9-16.6(1) GENERAL**

All material used in the construction of the fence shall be new. Iron or steel material shall be galvanized or aluminum coated as specified. Imperfectly galvanized or aluminum coated material, or material upon which serious abrasions of galvanizing or aluminum coating occur, will not be acceptable.

**9-16.6(2) GLARE SCREEN FABRIC**

Glare screen fabric shall consist of diamond woven wire mesh. The fabric wire may be 0.148 inch diameter aluminum alloy complying with the Aluminum Association requirements for alloy 6061T94, or it may be 0.148 inch diameter (9 gage) iron or steel wire which shall meet all of the requirements of ASTM A 392 galvanized or A 491 for aluminum coated, except that galvanizing of Type 2 glare screen fabric shall be not less than 0.8 ounce per square foot and shall be done before weaving. Aluminum coating shall be Class II.

Type 1 glare screen mesh size shall be approximately a 1 inch diamond. Type 2 glare screen mesh size shall be a maximum of 3-1/2 inch vertical and 5-1/2 inch horizontal. The design shall permit the slats to be installed in a vertical position as shown in WSDOT Standard Plans without distortion of the slats.

**9-16.6(3) POSTS**

Line posts for Type 1 glare screen shall be 1.5 inches by 1.875 inches hot-dip galvanized steel H column with a minimum weight of 2.8 pounds per linear foot. Line posts for Type 2 glare screen shall be 1.95 inches by 2.25 inches hot-dip galvanized steel H column with a minimum weight of 4.0 pounds per linear foot, or 2 inch inside diameter hot-dip galvanized steel pipe with a nominal weight of 3.65 pounds per linear foot provided only one type shall be used on any one Project.

End, corner, brace, and pull posts shall be 2 inch inside diameter hot-dip galvanized steel pipe with nominal weight of 3.65 pounds per linear foot. Intermediate pull posts (braced line posts) shall be H column as specified for line posts. Brace post sleeves shall be 2-1/2 inch inside diameter hot-dip galvanized steel pipe with nominal weight of 5.79 pounds per linear foot.

The base material for the manufacture of steel pipes used for posts shall conform to the requirements of ASTM A 53, except the weight tolerance on tubular posts shall be applied as follows. The base material for the manufacture of steel H columns shall meet the requirements of ASTM A 675.

Posts provided for glare screen will have an acceptance tolerance on the weight per linear foot, as specified, equal to plus or minus 5 percent for tubular and H-section posts. This tolerance applies to each individual post.

All posts, braces, and top rails shall be hot-dip galvanized. They shall have a minimum average of 1.8 ounces zinc coating per square foot of surface area with no individual test being below 1.6 ounces zinc coating per square foot of surface area. In the case of members made from pipe, this area is defined as the total area inside and outside. A sample for computing the average of weight of coating is defined as a 12 inch piece cut from each end of the galvanized member.

**9-16.6(4) TENSION WIRE**

Top and bottom tension wire shall be 7 gage coil spring steel wire of good commercial quality and shall have a zinc coating averaging 0.8 ounces per square foot of surface area.

**9-16.6(5) CABLE**

The tension cable shall be 1/4 inch diameter aluminum coated or hot-dip galvanized, 7 wire strand steel cable conforming to the requirements of ASTM A 474 for aluminum coated or ASTM A 475 for galvanized, High-Strength Grade. Galvanizing shall be Class A.

**9-16.6(6) CABLE AND TENSION WIRE ATTACHMENTS**

All tension wire and cable attachments shall be hot-dip galvanized steel conforming to the requirements of AASHTO M 232 unless otherwise specified in the Contract. Eye bolts shall have either a shoulder or a back-up nut on the eye end and be provided with an eye nut where needed or standard hex nut and lock washer and be 5/8 inch diameter for tension cable and 3/8 inch diameter for tension wire and of sufficient length to fasten to the type of posts used. Where the eye bolt is to be installed through a pipe section, two lead washers and one steel washer shall also be provided. Turnbuckles shall be of the shackle end type, 1/2 inch diameter, with standard takeup of 6 inches and provided with 3/8 inch diameter pins. Thimbles shall be light weight wire rope thimbles for use with 1/4 inch diameter cable. Wire rope clips shall have a U-bolt diameter of 5/16 inch for use with 1/4 inch diameter cable. Anchor shackles shall be 3/8 inch diameter with a minimum distance between eyes of 1-1/16 inch and a pin diameter of 7/16 inch. Seizing shall be 0.032 inch diameter galvanized annealed iron wire.

**9-16.6(7) SLATS****9-16.6(7)A WOOD SLATS**

Wood slats shall be 3/8 inch by 2-3/8 inch by the height designation of the fence. Material shall be finished and treated cedar or redwood and shall be free from loose knots, cracks, and other imperfections. A dimensional tolerance of  $\pm 1/16$  inch in width or thickness is allowed provided that the maximum space between slats does not exceed 3/4 inch.

**9-16.6(7)B PLASTIC SLATS**

Plastic slats shall be 3/8 inch by 2-3/8 inch by the height designation of the fence. They shall be manufactured from tubular polyethylene color pigmented material consisting of high density virgin polyethylene and color pigments, designed to retard ultraviolet penetration. The material shall have a minimum wall thickness of 0.0030 inch  $\pm$  0.0003 inch and shall remain flexible without distortion and without becoming brittle through a temperature range of -70°F to + 250°F. Tensile strength shall be at least 3600 psi and the melt index shall not exceed 0.25.

Plastic slats shall be retained in place by means of U-shaped retainer members at the bottom and top of the fence. Retainer members shall be of the same material as the slats.

The color for plastic slats will be approved by the Engineer from samples submitted by the Contractor.

**9-16.6(8) FITTINGS**

Fittings shall be malleable cast iron or pressed steel and galvanized in accordance with the requirements of AASHTO M 232.

Fittings for any particular fence shall be those furnished by the manufacturer of the fence.

**9-16.6(9) FABRIC BANDS AND STRETCHER BARS**

Fabric bands shall be 1/8 inch by 1 inch nominal and stretcher bars 3/16 inch by 3/4 inch nominal. Nominal shall be construed to be the area of the cross-section of the shape obtained by multiplying the specified width by thickness. A variation of minus 5 percent from this theoretical area shall be construed as "nominal" size. Both shall be hot-dip galvanized to meet the requirements of ASTM F 626.

**9-16.6(10) TIE WIRE**

Tie wire shall be 9 gage aluminum wire complying with the ASTM B 211 for alloy 1100 H14 or 9 gage galvanized wire meeting the requirements of AASHTO M 279. Galvanizing shall be Class 1.

**9-16.7 RESERVED****9-16.8 WEATHERING STEEL BEAM GUARDRAIL****9-16.8(1) RAIL AND HARDWARE**

Steel for rail elements and terminal sections shall conform to ASTM A 606 or ASTM A 607. Bolts, nuts, and washers for installation of the weathering steel shall be manufactured from steel conforming to ASTM A 242M and shall not be galvanized. If required, 6 inch channels and fittings shall conform to ASTM A 242. In addition, all steel for the guardrail components shall conform to one of the following chemical compositions, percent (ladle):

**Composition**

	<b>C</b>	<b>Mn</b>	<b>P</b>	<b>S</b>	<b>Si</b>	<b>Cu</b>	<b>Cr</b>	<b>Ni</b>	<b>Zr</b>
No. 1	0.12 Max.	0.20 to 0.50	0.07 to 0.15	0.05 Max.	0.25 to 0.75	0.25 to 0.55	0.30 to 1.25	0.65 Max.	-----
No. 2	0.12 Max.	0.50 to 1.00	0.12 Max.	0.05 Max.	0.20 to 0.90	0.50 Max	0.40 to 1.00	1.00 Max.	0.10 Max.

Blast cleaning or pickling to remove mill scale will not be required. All fabricated steel parts shall be handled with care to avoid gouges, scratches, and dents. The steel shall be kept clean of all foreign material, such as paint, grease, oil,

chalk marks, crayon marks, concrete spatter, or other deleterious substances. Natural oxidation of the steel will not be considered foreign material. Storage in transit, in open cars and trucks, for an extended period will not be permitted. Steel parts stored outside in yards or at Job Sites shall be positioned to allow free drainage and air circulation.

#### **9-16.8(2) ANCHORS**

Guardrail anchors may either be furnished as provided in Section 9-16.3(5) or they may be nongalvanized and fabricated from steel conforming to ASTM A 242 with the exception that all Type 1 anchors shall have galvanized cable and fittings as specified in Section 9-16.3(5).

#### **9-16.8(3) POSTS AND BLOCKS**

Posts and blocks for weathering steel beam guardrail shall comply with the requirements of Section 9-16.3(2).

### **SECTION 9-17 FLEXIBLE GUIDE POSTS**

#### **9-17.1 GENERAL**

See Section 8-10 for flexible delineator posts.

Flexible guide posts shall be made of a flexible, nonwarping, nonmetallic, durable plastic material; shall be resistant to damage due to impact, ultraviolet light, ozone, hydrocarbons, and other effects of atmospheric weathering; shall resist stiffening with age; and shall be designed for a minimum life equaling 60 months of outdoor service.

The post system shall be designed for permanent installation to resist overturning, twisting, and displacement from wind and impact forces.

Each flexible guide post shall be permanently identified with the manufacturer's name, the month and year of fabrication and a mark indicating the recommended burial depth. The letters shall be solvent resistant, a minimum of 1/4 inch in height, and permanently affixed to the post unless otherwise specified in the Contract, the color of the guide post shall be white or brown as indicated on the Drawings. Guide post length shall be in accordance with Section 8-10.3.

The reflective panel on a flat or elliptical guide post shall have a minimum width of 3 inches facing traffic. The reflective sheeting shall have a minimum area of 24 square inches (3 inches by 8 inches). The reflective panel on a round guide post shall have a 9 inch minimum band of reflective sheeting visible for 360 degrees.

#### **9-17.2 LABORATORY TESTS**

Ten guide posts of each model shall be conditioned in an oven for two hours at  $120^{\circ}\text{F} \pm 3\text{F}^{\circ}$ . After conditioning, the guide post shall be bent backwards at 90 degrees from the vertical to simulate a field impact. The guide post shall, without cracking, recover to within 10 degrees of its original position within five minutes. Color shall remain unchanged. Any appreciable change in color, cracking on more than one face, or not returning to within 10 degrees of vertical, is considered a failure. At least 70 percent of the posts must pass to be considered for preapproval.

The same ten guide posts tested for heat resistance shall be tested for cold resistance. The guide posts shall be conditioned for 24 hours at  $-20^{\circ}\text{F}, \pm 3\text{F}^{\circ}$ , then subjected to the same testing as for heat resistance. The guide posts shall conform to the same cracking, color, and recovery standards as for heat resistance. At least 70 percent of the posts must pass to be considered for preapproval.

Three guide posts of each model shall be subjected to deflection testing. The guide posts shall be fixed near the base in such a way that 4 feet of the post is cantilevered. The guide posts shall then be loaded 1/2 inch from the free end until collapse is observed. (Collapse is defined as the point at which the guide post can no longer resist any further loading.) The stress at collapse shall be calculated as follows:

$$P = K(Q/b)$$

Where:

- P is the equivalent stress in pounds per square foot.
- Q is the load at collapse in pounds.
- b is the post width (diameter of major axis) in inches.
- K is constant equal to 6 inches per square foot.

The value of P shall be no less than 3.43 pounds per square foot for round guide posts and 5.30 pounds per square foot for flat or elliptical guide posts. Any load below these values or cracking of more than one face, of any of the guide posts is considered a failure.

The three guide posts subjected to deflection testing shall be subjected to cyclic loading with an amplitude of 2 inches at the tip, with a cycle testing machine. Each guide post shall be cycled 30,000 times at 60 cycles per minute. When the cyclic tests are completed, the three guide posts shall again be subjected to deflection testing. The average load of the posts after cyclic loading shall be a minimum of 80 percent of the average load of the posts tested before cyclic loading. A value below this limit is considered a failure.

Three guide posts of each model shall be subjected to a 5.5-pound deflection test. The guide posts shall be fixed near the base in such a way that 4 feet of the post is cantilevered. The guide post shall then be loaded 1/2 inch from the free end with a 5.5-pound weight. A deflection greater than 29 inches is considered a failure.

A 9 inch specimen from the unreflectorized portion of each of three guide posts shall be prepared. The specimens shall be cycled at 1000 hours in a weatherometer in accordance with ASTM G 53 (3 hr. 60C UV, 3 hr. 50C CON). The

specimens shall show no signs of delamination, distress, or discoloration. Physical properties of tensile strength and rigidity shall be maintained within 80 percent of the unconditioned values.

### **9-17.3 FIELD TESTS**

Ten guide posts of each model, supplied in accordance with Section 9-17.4, shall be installed by the manufacturer's representative at the SPU Materials Laboratory designated test site. Anchoring Materials shall be driven such that the anchor is flush with, or below, the ground level. The test temperature shall be at or below 50°F.

The ten guide posts shall be struck seven times at 35 mph, then two times at 55 mph, by a car or equivalent hood and bumper device with an 18 inch height. After each impact, the delineators shall be inspected for the following criteria:

1. A minimum of 50 percent of the reflective sheeting shall be retained undamaged. An area of damage greater than 50 percent is considered a failure.
2. If the guide post leans more than 10 degrees from vertical it is considered a failure.
3. Any cracking, other than surface cracking evident on only one face of the post, is considered a failure.
4. Pullout in excess of 3 inches is considered a failure.

If an individual guide post fails any one of the above criteria in the 35 mph series of impacts, the product is unacceptable. At least 70 percent of the guide posts must pass each criteria in the 55 mph series of impacts to be acceptable.

### **9-17.4 APPROVAL**

The Contractor shall submit a Manufacturer's Certificate of Compliance stating all materials meet or exceed Contract requirements. See Section 1-05.3.

## **SECTION 9-18 PRECAST TRAFFIC CURB AND BLOCK TRAFFIC CURB**

### **9-18.1 PRECAST TRAFFIC CURB**

#### **9-18.1(1) AGGREGATES AND PROPORTIONING**

The cement, fine and coarse aggregate, and reinforcing steel to be used in the manufacture of precast concrete traffic curb shall meet the following requirements and be submitted to the SPU Materials Laboratory for approval:

1. Aggregates shall conform to the requirements of Section 9-03 except that they shall be uniformly graded up to a maximum size of 3/8 inch and shall contain sufficient fine fractions to permit securing the type of surface finish specified herein. The aggregate shall be approved by the SPU Materials Laboratory before it is used.
2. Reinforcing steel shall conform to the requirements of Section 9-07.
3. The cement concrete mix shall be composed of not less than 1 part Portland cement to approximately 2 parts of fine concrete aggregate and 3-1/4 parts of coarse concrete aggregate adjusted to secure proper workability. The Contractor will be allowed to use a different concrete mix if approved by the Engineer, provided that it develops not less than 4,000 psi compressive strength when tested at the age of 28 Days.

#### **9-18.1(2) MIXING**

The mixers shall be kept in good repair and shall be equipped with an automatic timing device, and a positive device for regulating the quantity of water added to each batch. The latter device must be approved by the Engineer before use.

After all Materials, including water, have been placed in the mixer, the Materials shall be mixed for a period of not less than 1-3/4 minutes, or as long as necessary to produce a uniform concrete mix. No water shall be added to any batch after completion of the mixing period. Each batch of concrete shall be completely emptied from the mixer before placing more Materials in it. A batch which has not been placed within 30 minutes from the time water was first added shall not be used.

The amount of water in the concrete shall be kept to a minimum, consistent with the manufacture of a dense mix, free from air bubbles and surface defects in excess of the tolerance limits specified.

#### **9-18.1(3) FORMS**

Forms for precast traffic curbs shall be steel or special concrete mold. The use of forms or molds made of plaster of paris, wood, or other absorptive Material will not be permitted.

Bulkheads shall be tight fitting so that there is no leakage of mortar between the bulkhead and form.

The Materials and methods used for lubricating the forms shall be such that they do not result in discoloration of the curb at any time. A minimum quantity of lubricant shall be used and all excess lubricant shall be removed.

#### **9-18.1(4) PLACING CONCRETE**

The concrete shall be consolidated by external vibration, or by other means if approved by the Engineer, to produce a dense concrete throughout, having a minimum of air bubbles and honeycombing.

Reinforcing steel shall be placed and maintained in its proper position as shown in the Standard Plans.

Curb or buttons shall not be manufactured in an atmospheric temperature of less than 50°F.

#### **9-18.1(5) REMOVAL OF FORMS**

The curb shall be removed from the molds or forms with instructions, or by some other identified method, acceptable to the Engineer.

The loosening of the curb from the molds shall be carefully performed to avoid excessive shock and straining of the curb. When, in the opinion of the Engineer, undue shock is required to remove the curb from the molds, the stripping operation shall be deferred until such time as the curb may be removed without breakage.

#### **9-18.1(6) CURING CONCRETE**

Immediately after the concrete has been placed and consolidated in the mold, each unit shall be placed in a curing room fitted with water sprays and maintained at a relative humidity of not less than 90 percent and a temperature of not less than 60°F, nor more than 100°F. Each unit shall remain in the curing room for a period of not less than 10 Days, except that if Type III cement is used, the period in the curing room may be reduced to 5 Days.

#### **9-18.1(7) FINISH**

The curb shall have a smooth, glassy finish on all exposed surfaces.

Excess honeycombing in the back of the curb may be cause for rejection of the curb. Honeycombing areas in the back of the curb which, in the opinion of the Engineer, are not detrimental to the curb need not be patched. The workmanship of the bottom finish shall be such that no mechanical interlocking of the mortar bed and the curb bottom or anchor groove occurs.

#### **9-18.1(8) SURFACE TREATMENT**

As soon as the units have been taken out of the curing room and thoroughly surface dried to a depth of at least 1/4 inch, two coats of a water-repellent compound, meeting the requirements of Section 9-18.4, shall be brush applied. When the first coat has dried, the second coat of water-repellent compound shall be applied.

#### **9-18.1(9) DIMENSIONS AND SHAPE**

The curb shall conform to the dimensions and shape shown on the Standard Plans within a tolerance of 1/4 inch in length and 1/8 inch in alignment.

#### **9-18.1(10) CURB LENGTHS AND ANCHOR HOLES**

413a and 413b curb shall be made in 3'-0" maximum length sections. Circular curbing shall be made only for such radii as called for in the details on the Drawings.

Each 413b curb section shall have two (2) one (1) inch diameter holes as shown in Standard Plan no. 413a.

#### **9-18.1(11) DEFECTIVE CURB**

Not more than 2 percent of the top area in any one piece of curb shall be defective, and not more than 5 percent of the total length of the top corners of reflecting faces in any one piece of curb shall be broken or rounded. There shall be not more than 30 air holes in any linear foot of curb, nor more than 50 air holes in any 3 linear feet of curb. All curb having defects in excess of any of the listed defects in this Section will be considered defective in accordance with Section 1-05.7. Failure to reject such curb at the time of form removal may be waived if and only if 90 percent of the curb laid has less than 10 percent of the maximum allowable number of each type defect specified in this paragraph; however, all defects shall be immediately repaired. The Contractor agrees that its refusal to repair defects is grounds for the Engineer to declare the curb defective.

An air hole shall be defined as any hole 1/8 inch or larger in diameter or depth.

The sum of the length of the lines of discoloration caused by a cracked mold in any one piece of curb shall not exceed 50 percent of the length of the curb, and the maximum length of any single line of discoloration shall not exceed 18 inches. 75 percent of the curb laid shall be entirely free from lines of discoloration. The employment of heat to obliterate lines of discoloration will not be permitted. The process used to obliterate lines of discoloration shall be subject to the approval of the Engineer.

The repairing of molds which are chipped or broken shall be done in a manner that the broken or chipped areas are not apparent on the curb made in those molds.

All curb in which surface checking develops during the first five Days after manufacture will be rejected.

Hidden air holes at or immediately below the exposed surface of the curb which are in excess of the limits specified and are disclosed by testing the surface by means of a rubber hammer, will be considered defective in accordance with Section 1-05.7.

All curb in which cracking is in evidence immediately after removal from the molds will be considered defective. A crack is defined as any continuous separation of the concrete greater than 3 inches in length.

All curb which varies in dimensions, alignment, or surface contour in excess of the tolerance specified will be considered defective.

#### **9-18.1(12) REPAIRING CURB**

Curb having defects which are not sufficient cause for its rejection shall be neatly repaired immediately after removal from the molds in a manner subject to the approval of the Engineer. However, no patching or other repairs shall be made without the permission of the Engineer. Patches shall be undercut if, in the opinion of the Engineer, this operation is necessary to achieve an acceptable patch.

All holes larger than 1/16 inch diameter in the exposed surface of acceptable curb or buttons shall be filled with cement mortar.



**9-18.1(13) IDENTIFICATION MARKING**

The date of manufacture, the length, and identification number corresponding to the detail layout shall be marked in black paint on the back or end of each piece of curb.

Rejected curb shall be marked on the back or end surfaces in a practical and semi-permanent manner to identify each cause of rejection.

**9-18.1(14) SHIPPING**

No unit of curb shall be shipped from the manufacturing plant prior to 21 Days after manufacture, except that if Type III cement has been used, the units may be shipped 14 Days after manufacture.

**9-18.1(15) SAMPLING AND INSPECTION**

The Contractor shall submit, for the approval of the Engineer, an advance sample of curb which shall be at least equivalent in color, surface texture, and bottom finish to the standard as set forth in these Specifications. No repairing of any kind shall be done on the advance sample. Upon approval, the advance sample shall be stored at the plant or site of manufacture in a location readily accessible to the Inspector where there is adequate daylight for examination. The advance sample shall be protected from damage and discoloration and shall be used as a standard of comparison for color, surface texture, and bottom finish for all curb manufactured. All curb furnished shall be equivalent in the foregoing respects.

The inspection at the plant will be made just prior to shipment, at which time examination will be made of the alignment, contour, color, cracks, surface damage or discoloration, broken corners or edges, and any other defects which may have developed, and to check the laboratory test reports for strength. However, intermediate inspections may be made to determine surface checking and hidden air holes if it is impractical to examine for these defects at the final inspection.

**9-18.2 RESERVED****9-18.3 BLOCK TRAFFIC CURB**

Block traffic curb shall be as shown on Standard Plan no. 413b.

The curb units shall be made from Portland cement and high quality sand and gravel, the proportions of which shall be left to the discretion of the producer as long as the unit develops a minimum compressive strength of 1,600 psi at 28 Days when tested for end loading.

The proportions of sand, gravel, and cement, the type of forms used, and the method of compacting the concrete in the forms shall all be such that as dense, smooth, and uniform a surface as is practicable for a concrete masonry unit is obtained on the finished curb units. The faces that are to be exposed shall be free from chips, air holes, honeycomb, or other imperfections, and cracks shall be tight, with the following exceptions: not more than 5 percent of each curb unit contains cracks, contains small chips which are not larger than 1/4 inch in any dimension, and air holes which are not larger than 1/4 inch in diameter or depth. The units used in any contiguous line of curb shall have approximately the same color and surface characteristics.

**9-18.4 WATER-REPELLENT COMPOUND**

The water-repellent compound shall be a clear, penetrating type, silicone resin base compound containing no filler or other Material which leaves a film on the surface of the masonry after it is applied, and bonds securely to the masonry. It shall be of such consistency that it can be applied readily by brush or spray to the masonry at atmospheric temperature down to minus 20°F.

The average absorption of three test specimens treated with the water-repellent compound, when tested in accordance with the methods used in the Laboratory shall not exceed 2 percent after being partially immersed in water for 72 hours immediately after curing.

The average moisture vapor transpiration (breathing) of three test specimens, when tested in accordance with the methods used in the Laboratory, shall be not less than 50 percent at seven Days.

The water-repellent compound shall be approved by the Laboratory before it is used.

**9-18.5 SODIUM METASILICATE**

Sodium metasilicate shall comply with ASTM D 537.

**SECTION 9-19 PRESTRESSED CONCRETE GIRDERS****9-19.1 CONCRETE AGGREGATES AND PROPORTIONING**

The concrete for prestressed girders shall have the minimum compressive strengths as specified on the Drawings. Aggregates used in the mix shall conform to the following:

1. Coarse aggregate shall be in accordance with Section 9-03.1(3).
2. Fine aggregate shall be in accordance with Section 9-03.1(2), Class 1 or Class 2.
3. The manufacturer may revise the grading of the coarse aggregate provided that the concrete mix design is qualified with the modified gradation. An alternative combined gradation conforming to Section 9-03.1(4) may also be used.

The Contractor shall submit for review a proposed mix design for each design strength. Included shall be evidence acceptable to the Engineer that the proposed mix design meets design requirements. The mix design review will not preclude any requirements for the concrete placed in the girders.

The concrete mix shall be prepared and placed in accordance with the appropriate sections of Section 6-02.

Water used in mixing the concrete shall conform to the requirements of Section 9-25.1.

Portland cement and hydraulic cement shall conform to the requirements of Section 9-01.

Chemical admixtures and pozzolans shall conform to the provisions of Section 9-23.6.

The total chloride ion (C1-) content of the mixed concrete, expressed as a percent by mass of cement, shall not exceed 0.06 percent.

#### **9-19.2 REINFORCEMENT**

Reinforcement shall meet the requirements of Section 9-07 and shall be placed in accordance with the requirements of Section 6-02.3(24).

### **SECTION 9-20 CONCRETE PATCHING MATERIAL, GROUT AND MORTAR FOR STRUCTURES**

#### **9-20.1 PATCHING MATERIAL**

Concrete patching material will be prepackaged mortar extended with aggregate. The amount of aggregate for extension shall conform to the manufacturer's recommendation.

#### **9-20.2 SPECIFICATIONS**

Patching mortar and patching mortar extended with aggregate shall contain cementitious material and meet the requirements of Sections 9-20.2(1) and 9-20.2(2). The Manufacturer shall use the services of an independent laboratory that has an equipment calibration verification system and a technician training and evaluation process per AASHTO R-18 to perform all tests specified in Section 9-20.

##### **9-20.2(1) PATCHING MORTAR**

Patching mortar shall conform to the following requirements:

	ASTM TEST METHOD	SPECIFICATION
<b>COMPRESSIVE STRENGTH</b>		
at 3 hours	C 39	Minimum 3,000 psi
at 24 hours	C 39	Minimum 5,000 psi
<b>LENGTH CHANGE</b>		
at 28 Days	C 157	0.15 percent maximum
Total Chloride Ion Content	C 1218	1 lb/yd <sup>3</sup> maximum
<b>BOND STRENGTH</b>		
at 24 hours	C 882 (As modified by C 928, Section 8.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	C 672 (As modified by C 928, Section 8.4)	1 lb/ft <sup>2</sup> maximum

##### **9-20.2(2) PATCHING MORTAR EXTENDED WITH AGGREGATE**

Patching mortar extended with aggregate shall meet the following requirements:

	ASTM TEST METHOD	SPECIFICATION
<b>COMPRESSIVE STRENGTH</b>		
at 3 hours	C 39	Minimum 3,000 psi
at 24 hours	C 39	Minimum 5,000 psi
<b>LENGTH CHANGE</b>		
at 28Days	C 157	0.15 percent maximum
<b>BOND STRENGTH</b>		

at 24 hours	C 882 (As modified by ASTM C 928, Section 8.5)	Minimum 1,000 psi
Scaling Resistance (at 25 cycles of freezing and thawing)	C 672	2 Maximum Visual Rating
Freeze thaw	C 666	Maximum expansion 0.10% Minimum durability 90.0%

**9-20.2(3) AGGREGATE**

Aggregate used to extend the patching mortar shall meet the requirements of Section 9-03.1(3) and be AASHTO Grading No. 8. A Manufacturers Certificate of Compliance shall be required showing the aggregate source and the gradation.

**9-20.2(4) WATER**

Water shall meet the requirements of Section 9-25.1. The quantity of water shall be within the limits recommended by the manufacturer

**9-20.3 GROUT**

Grout is a mixture of Portland or blended hydraulic cement and water with or without aggregates and with or without admixtures. Grout may also contain pozzolans and/or concrete admixtures. Grout may be a Contractor's submitted mix design or a Manufacturer's prepackaged grout product.

All prepackaged grouts shall be used in accordance with the manufacturer's recommendations, including but not limited to, shelf life, mixing, surface preparation, and curing.

Where required, all 2-inch cube specimens fabricated in the field shall be made in accordance with WSDOT TM-813. All 2-inch cube specimens fabricated in a laboratory shall be made in accordance with AASHTO T-106. All 2-inch cube specimens shall be tested in accordance with AASHTO T-106.

When coarse aggregate is used, specimens shall be fabricated in accordance with AASHTO T-23 and tested in accordance with AASHTO T-22.

**9-20.3(1) GROUT TYPE 1 FOR POST-TENSIONING APPLICATIONS**

Grout Type 1 shall be a Class C prepackaged, pumpable, nonbleed, nonshrink, and high-strength material conforming to the requirements of AASHTO LRFD Bridge Construction Specifications, Section 10.9.3. The water/cement ratio shall not exceed 0.45.

**9-20.3(2) GROUT TYPE 2 FOR NONSHRINK APPLICATIONS**

Grout Type 2 shall be a nonshrink, prepackaged material meeting the requirements of ASTM C-1107. The minimum compressive strength shall be 4000-psi at 7-Days.

**9-20.3(3) GROUT TYPE 3 FOR UNCONFINED BEARING PAD APPLICATIONS**

Grout Type 3 shall be a prepackaged material meeting the requirements of ASTM C-882 for minimum of 2000-psi bond strength and ASTM C-157 for maximum of 0.08-percent dry shrinkage. The minimum compressive strength shall be 4000-psi at 7-Days.

**9-20.3(4) GROUT TYPE 4 FOR MULTIPURPOSE APPLICATIONS**

Grout Type 4 shall be a multipurpose grout material for structural and nonstructural applications. The grout shall be produced using Portland Cement Type I/II. The water to cementitious material ratio shall not exceed 0.40 and water-reducing admixtures may be used. Multipurpose grout may be extended up to three parts fine aggregate to one part cement. The minimum compressive strength shall be 4000-psi at 7-Days. Substitution of fly ash for cement is allowed up to 20-percent.

**9-20.4 MORTAR**

Mortar shall be material made from Portland or blended hydraulic cement, water, and fine aggregate.

**9-20.4(1) FINE AGGREGATE FOR MORTAR**

Fine Aggregate for mortar shall conform to the requirements of ASTM C 144.

**9-20.4(2) MORTAR TYPE 1 FOR CONCRETE SURFACE FINISH**

Mortar Type 1 for concrete surface finishing shall be either prepackaged or a Contractor-recommended blend of Portland Cement Type I/II and fine aggregate conforming to Section 9-20.4(1). If the Class 1 concrete surface finishing mortar is a Contractor-recommended blend, it shall conform to the sand-to-cement ratios specified in Section 6-02.3(14)A.

**9-20.4(3) MORTAR TYPE 2 FOR MASONRY APPLICATIONS**

Mortar Type 2 for masonry shall be either prepackaged or a Contractor-recommended blend of Portland Cement Type I/II and fine aggregate conforming to 9-20.4(1).

**9-20.4(4) MORTAR TYPE 3 FOR CONCRETE REPAIR**

Mortar Type 3 shall be a prepackaged material that does not include expansive admixtures. Aggregate extension and mixing procedures shall be in accordance with the manufacturer's recommendation. The minimum compressive strength shall be 4000-psi at 7-Days.

**SECTION 9-21 PLASTIC TRAFFIC BUTTONS AND LANE MARKERS****9-21.1 PLASTIC TRAFFIC BUTTON AND LANE MARKER TYPE 1****9-21.1(1) GENERAL**

Plastic Traffic Button and Lane Marker Type 1 shall be composed of thermosetting resins, pigments and inert ingredients and shall be of uniform composition throughout. The color shall be yellow or white to correspond to the delineation line color.

**9-21.1(2) PHYSICAL AND CHEMICAL PROPERTIES**

The traffic buttons and lane markers shall be of uniform composition and free from surface irregularities, cracks, checks, chipping, peeling, spalling, crazing, and other physical defects impairing their appearance, application, or durability.

The molding process shall be such that coarse aggregate particles on the curved surface are covered by not less than 1/16 inch of pigmented Material.

The and lane marker Type 1 shall meet the following requirements (see Standard Plan no. 700):

LANE MARKER/TRAFFIC BUTTON (DESCRIPTION)	LANE MARKER TYPE 1
Diameter	3-7/8 inch to 4-1/8 inch
Weight (pounds)	0.275 min.
State Reflectance	80% min.
Impact Resistance (Inch-pounds)	15 min.
Planeness of Base:	
Concavity (Inches)	0.02 max.
Convexity (Inches)	0.05 max.
Titanium Dioxide (% by weight)	21 min.
Resin Content (% by weight)	20 min.

**9-21.1(3) TEST METHODS**

Test methods shall be as follows:

- Reflectance:** Reflectance will be measured with a photovolt Reflectance Meter or its equivalent by comparing the buttons to a 75 percent brightness standard.
- Impact Resistance:** Impact resistance will be measured by allowing a 1 pound steel ball to fall 15 inches (free fall) onto the lane marker, supported by but not bonded to a steel base plate.
- Titanium Dioxide Content:** The titanium dioxide content will be determined by ashing representative portions of the lane marker, treating the ash with a boiling  $(\text{NH}_4)_2\text{SO}_4 \cdot \text{H}_2\text{SO}_4$  solution, filtering, and measuring the absorbance of the filtrate at about 410 millimicrons. Calibration shall be with known samples using ASTM D 921.
- Resin Content:** Resin content will be determined by ashing and igniting representative portions of the marker.

Additional information on the test methods is available from the Seattle Public Utilities' Materials Laboratory.

**9-21.2 LANE MARKERS TYPE 2A AND TYPE 2B**

The markers shall consist of an acrylic plastic shell filled with a tightly adhering potting compound. The shell shall contain prismatic reflective faces as shown in Standard Plan no. 700 to reflect incident light from opposite directions.

**9-21.2(1) PHYSICAL PROPERTIES**

The shell shall be molded of methyl methacrylate or acrylonitrile butadiene styrene (ABS).

Filler shall be a potting compound selected for strength, resilience, and adhesion adequate to pass physical requirements as outlined herein.

The outer surface of the shell shall be smooth except for purposes of identification and shall contain methyl methacrylate reflective faces in the color specified. As an option, thin untempered glass may be bonded to the prismatic reflective faces to provide an abrasion resistant surface.

The base of the marker shall be substantially free from gloss or substances that may reduce its bond to adhesive. This shall be done by embedding sand or inert granules on the surface of the potting compound prior to its curing.

The markers shall be fabricated as follows:

LANE MARKER (DESCRIPTION)	LANE MARKER TYPE 2A	LANE MARKER TYPE 2B
Dimensions of Plastic Shells	4 inch x 4 inch x 0.65 inch or octagonal w/4 inch across flats	4.7 inch x 2.3 inch x 0.52 inch
Slope of Reflecting Face	20 deg. to 30 deg.	20 deg. to 30 deg.
Area of Each Reflecting Surface	3.0 to 3.25 square inches	1.87 square inches

#### 9-21.2(2) OPTICAL REQUIREMENTS

##### 1. Definitions:

Horizontal entrance angle shall mean the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker.

Observation angle shall mean the angle at the reflector between observer's line of sight and direction of the light incident on the reflector.

Specific intensity (S.I.) shall mean candlepower of the returned light at the chosen observation and entrance angles for each foot-candle of illumination at the reflector on a plane perpendicular to the incident light.

##### 2. Optical Requirements: The specific intensity of each crystal reflecting surface at 0.2 degrees observation angle shall be not less than the following when the incident light is parallel to the base of the marker:

Hor. Ent. Angle	S.I.
0°	3.0
20°	1.2

Yellow reflectors shall be not less than 60 percent and red reflectors not less than 25 percent of the above values.

##### 3. Optical Testing Procedure: A random lot of markers will be tested. The markers to be tested shall be located with the center of the reflecting face at a distance of 5 feet from a uniformly bright light source having an effective diameter of 0.2 inch.

The photocell width shall be 0.05 inch. It shall be shielded to eliminate stray light. The distance from light source center to the photocell center shall be 0.21 inch. If a test distance of other than 5 feet is used, the source and receiver dimensions and the distance between source and receiver shall be modified in the same proportion as the test distance.

Failure of more than 4 percent of the samples shall be cause for rejection of the lot.

#### 9-21.2(3) STRENGTH REQUIREMENTS

Markers shall support a load of 2,000 pounds as applied in the following manner:

1. A marker shall be centered over the open end of a vertically positioned hollow metal cylinder. The cylinder shall be 1 inch high with an internal diameter of 3 inches and wall thickness of 1/4 inch. The load shall be slowly applied to the top of the marker through a 1 inch diameter by 1 inch high metal plug centered on the top of the marker.
2. Failure occurs with either a breakage or a significant deformation of the marker at any load of less than 2,000 pounds.

### SECTION 9-22 MONUMENT FRAMES AND COVERS

#### 9-22.1 GENERAL

Monument castings shall conform to the requirements of ASTM A 48, Class 30 and shall be free of porosity, shrink cavities, cold shuts or cracks, or any surface defects which would impair serviceability. Repair of defects by welding, or by the use of "smooth-on" or similar Material, will not be permitted. The manufacturer shall certify that the product conforms to the requirements of these Specifications.

Monument castings shall be machine finished or ground on seating surfaces to assure non-rocking fit in any position, and interchangeability. The foundry shall make standard frames and covers available to the Engineer to test fit and seating.

### SECTION 9-23 CONCRETE CURING MATERIALS, POZZOLANS AND ADMIXTURES

#### 9-23.1 SHEET MATERIALS FOR CURING CONCRETE

Sheet materials for curing concrete shall meet the requirements of AASHTO M 171, Sheet Materials for Curing Concrete, except that only white reflective type shall be used.

**9-23.2 LIQUID MEMBRANE-FORMING CONCRETE CURING COMPOUNDS**

Liquid membrane-forming compounds for curing concrete shall conform to the requirements of AASHTO M 148 (ASTM C 309) Type 1D or 2, Class A or B.

Each lot of liquid membrane-forming curing compound shall be sampled at the project site and tested for acceptance. Liquid membrane-forming curing compound shall not be used in the absence of satisfactory test results.

**9-23.3 RESERVED****9-23.4 RESERVED****9-23.5 BURLAP CLOTH**

Burlap cloth shall meet the requirements of AASHTO M 182, Class 4.

**9-23.6 CHEMICAL ADMIXTURES FOR CONCRETE**

Acceptance of chemical admixtures will be based on Manufacturer's Certificate of Compliance. If required by the Engineer, admixtures shall be sampled and tested before they are used. A 1-pint (500-milliliter) sample of the admixture shall be submitted to the Materials Laboratory for testing 10-days prior to use. Chemical Admixtures shall contain less than 1-percent chloride ion (Cl-) by weight of admixture.

**9-23.6(1) AIR-ENTRAINING ADMIXTURES**

Air-Entraining admixtures shall meet the requirements of AASHTO M 154 or ASTM C 260.

**9-23.6(2) TYPE A WATER-REDUCING ADMIXTURES**

Type A Water-Reducing admixtures shall conform to the requirements of AASHTO M 194 Type A or ASTM C 494 Type A.

**9-23.6(3) TYPE B RETARDING ADMIXTURES**

Type B Retarding admixtures shall conform to the requirements of AASHTO M 194 Type B or ASTM C 494 Type B.

**9-23.6(4) TYPE C ACCELERATING ADMIXTURES**

Type C Accelerating admixtures shall conform to the requirements of AASHTO M 194 Type C or ASTM C 494 Type C, and only nonchloride accelerating non-corrosive admixtures shall be used.

**9-23.6(5) TYPE D WATER-REDUCING AND RETARDING ADMIXTURES**

Type D Water-Reducing and Retarding admixtures shall conform to the requirements of AASHTO M 194 TYPE D OR ASTM C 494 TYPE D.

**9-23.6(6) TYPE E WATER-REDUCING AND ACCELERATING ADMIXTURES**

Type E Water-Reducing and Accelerating admixtures shall conform to the requirements of AASHTO M 194 Type E or ASTM C 494 Type E, and only nonchloride accelerating admixtures shall be used.

**9-23.6(7) TYPE F WATER-REDUCING, HIGH RANGE ADMIXTURES**

Type F Water-Reducing, High Range admixtures shall conform to the requirements of AASHTO M 194 Type F or ASTM C 494 Type F.

**9-23.6(8) TYPE G WATER-REDUCING, HIGH RANGE, AND RETARDING ADMIXTURES**

Type G Water-Reducing, High Range, and Retarding admixtures shall conform to the requirements of AASHTO M 194 Type G or ASTM C 494 Type G.

**9-23.6(9) TYPE S SPECIFIC PERFORMANCE ADMIXTURES**

Type S Specific Performance admixtures shall conform to the requirements of ASTM C 494 Type S. When a Type S admixture is used, a report on the performance characteristics of the Type S admixture shall be submitted along with the concrete mix design. The report shall describe the performance characteristics and provide data substantiating the specific characteristics of the Type S admixture in accordance with ASTM C 494.

**9-23.7 RESERVED****9-23.8 WATERPROOFING**

Concrete made with waterproofing admixtures shall have a percent absorption after immersion and boiling of less than 5.0 percent at seven days and a volume of permeable voids less than 11.0 percent at seven days per ASTM C 642. The Contractor shall submit evidence in the form of test results showing compliance with these specifications, when they submit their concrete mix design.

If the concrete requires air entrainment, the Contractor shall also submit evidence to the Engineer that the admixture will not adversely affect the air void system of the hardened concrete. Test results complying with ASTM C 457 shall be provided as evidence to satisfy this requirement.

**9-23.9 FLY ASH**

Fly ash shall conform to the requirements of AASHTO M 295 Class C or F including optional chemical requirements as set forth in Table 2 and with a further limitation that the loss on ignition shall be a maximum of 1.5 percent.

**9-23.10 GROUND GRANULATED BLAST FURNACE SLAG (GGBFS)**

Ground granulated blast furnace slag shall meet the requirements of AASHTO M 302, Grade 100 or Grade 120. The grade of the ground granulated blast furnace slag, the source, and type of manufacturing facility shall be certified on the cement mill test certificate.

**9-23.11 MICROSILICA FUME**

Microsilica Fume shall conform to the requirements of AASHTO M 307. The optional physical requirement for Reactivity with Cement Alkalies set forth in Table 3 will be required when Microsilica Fume is being used as an ASR mitigation measure.

**9-23.12 METAKAOLIN**

Metakaolin shall conform to the requirements of AASHTO M 295 Class N, including optional chemical requirements as set forth in Table 2 and with a further limitation that the loss on ignition shall be a maximum of 1.5 percent.

**SECTION 9-24 PLASTIC WATERSTOP****9-24.1 MATERIAL**

Waterstops shall be fabricated from a plastic compound, the basic resin of which shall be polyvinyl chloride. The compound shall contain such additional resins, plasticizers, inhibitors, or other material that when the Material is compounded, it shall meet the performance requirements given in this Specification.

Single-pass reworked Material of the same composition generated from the fabricator's waterstop production may be used. No reclaimed polyvinyl chloride shall be used.

All waterstops shall be molded or extruded in such a manner that any cross section is dense, homogeneous, and free from porosity and other imperfections.

Waterstops shall be symmetrical in shape, nominally 4 inches in width by 3/16 inch thick, and have a minimum of four ribs on each side of the bulb. The bulb thickness and diameter shall be as noted on the Drawings.

**9-24.1(1) TESTS OF MATERIAL**

The waterstops shall meet all of the physical and other test requirements of this material as defined in the Corps of Engineers Specifications for Polyvinyl Chloride Water Stop CRD-C572, except that the tear resistance of the material shall be not less than 160 pounds per inch. The Contractor shall furnish such sample material as required by the Engineer for the purpose of making tests.

**SECTION 9-25 WATER****9-25.1 WATER FOR CONCRETE**

Water for mortar or concrete, grout, and mortar shall be clear, apparently clean, and suitable for human consumption (potable). As determined by the Engineer, if the water contains substances that cause discoloration, unusual or objectionable smell or taste, or other suspicious content, the Engineer may require the Contractor to provide test results documenting that the water meets the physical test requirements and chemical limits described ASTM C1602 for nonpotable water.

Water from mixer washout operations may be used in concrete provided it meets or exceeds the above criteria as well as the following additional requirements:

1. Concrete with water from mixer washout operations shall not be used in bridge roadway deck slabs, flat slab bridge superstructures, modified concrete overlays, or prestressed concrete,
2. Specific gravity shall not exceed 1.07,
3. Alkalies, expressed as  $[\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O}]$  shall not exceed 600 ppm,
4. Shall be free of coloring agents,
5. If the wash water contains admixtures from different manufacturers, the Contractor shall provide evidence that the combination of admixtures are compatible and do not adversely affect the air void system of the hardened concrete as per Section 6-02.3(3), and
6. All tests to verify that the physical and chemical requirements are met, shall be conducted on the following schedule:
  - a. The physical requirements shall be tested on weekly intervals for four weeks and thereafter on monthly intervals,
  - b. The chemical requirements shall be conducted on monthly intervals, and
  - c. The specific gravity shall be determined daily in accordance with ASTM D 1429, Test Method D.



The Contractor shall use the services of a laboratory that has equipment calibration/verification system, and a technician training and evaluation process per AASHTO R-18 to conduct all tests. The laboratory shall use testing equipment that has been calibrated / verified at least once within the past 12 months to meet the requirements of each test procedure in accordance with the appropriate section of AASHTO R-18. Documentation of tester qualifications and equipment verification records shall be maintained and be available for review by the Engineer upon written notice. The Engineer's review of the laboratory facility, testing equipment personnel, and all qualification, calibration, and verification records will be conducted at the Engineer's discretion.

#### **9-25.2 WATER FOR IRRIGATION**

Water for irrigation shall not contain dissolved or suspended matter which is harmful to the plant Material on which it is to be used.

### **SECTION 9-26 EPOXY RESINS**

#### **9-26.1 EPOXY BONDING AGENTS**

##### **9-26.1(1) GENERAL**

Epoxy bonding agents shall be 2-component epoxy resin-base systems that meet the requirements of ASTM C 881, shall be furnished in the type, grade, and class specified, and shall meet the requirements below. When not specified, an appropriate grade and class shall be selected for the particular application. Epoxy bonding agents for patching external concrete shall be concrete-gray in color.

##### **9-26.1(1)A TYPE I AND TYPE IV**

Epoxy bonding agents used for bonding hardened concrete to hardened concrete and other materials shall be Type I for non-load bearing applications and Type IV for load bearing applications.

##### **9-26.1(1)B TYPE II AND TYPE V**

Epoxy bonding agents used for bonding freshly mixed concrete to hardened concrete shall be Type II for non-load bearing applications and Type V for load bearing applications.

##### **9-26.1(1)C TYPE III**

Epoxy bonding agents used for bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars and epoxy concretes used on traffic bearing surfaces shall be Type III.

##### **9-26.1(2) PACKAGING AND MARKING**

The components of the epoxy system furnished under these Specifications shall be supplied in separate containers that are non-reactive with the materials contained. The contents of each container shall be such that when the container contents are combined, a properly proportioned final mixture results.

Containers shall be identified as "Component A" (Contains the Epoxy Resin) and "Component B" (Contains the Curing Agent) and shall show the type, grade, class and mixing directions as defined by these Specifications. Each container shall be marked with the name of the manufacturer, the lot or batch number, the date of packaging, and the quantity contained in pounds or gallons.

Potential hazards shall be so stated on the package in accordance with the Federal Hazardous Products Labeling Act and State of Washington, Department of Labor and Industries Regulations for Shipment of Hazardous Products.

##### **9-26.1(3) CERTIFICATION**

If requested by the Owner, the manufacturer of the epoxy system shall certify that components A and B meet the requirements of this Specification before a sample will be accepted for testing by the Owner. The Manufacturer's Certificate of Compliance shall be furnished in accordance with Section 1-06.3.

##### **9-26.1(4) REJECTION**

Except as noted otherwise, the entire lot of both components may be rejected if samples submitted for test fail to meet any requirements of this Specification.

##### **9-26.1(5) ACCEPTANCE**

Acceptance of the Epoxy Bonding Agents for use on the project shall be based on a passing test report from the Materials Laboratory.

#### **9-26.2 EXPOXY ADHESIVE FOR LANE MARKERS**

##### **9-26.2(1) GENERAL**

Epoxy adhesives for lane markers shall meet the requirements of AASHTO M 237 for Type II - Standard Setting, High Viscosity, Epoxy Adhesive. In lieu of the square base test specimen molds for the Slant Shear Strength test specified in AASHTO M 237, cylindrical molds in accordance with ASTM C 882 may be used.

##### **9-26.2(2) PACKAGING AND MARKING**

Packaging and Marking of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(2).

**9-26.2(3) CERTIFICATION**

Certification of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(3).

**9-26.2(4) REJECTION**

Rejection of Epoxy Adhesive for Lane Markers shall meet the requirements of Section 9-26.1(4).

**9-26.2(5) ACCEPTANCE**

Acceptance of each lot of the Epoxy Adhesive for Lane Markers for use on the project shall be based on a Manufacturer's Certificate of Compliance.

**9-26.3 EPOXY GROUT/MORTAR/CONCRETE****9-26.3(1) GENERAL**

This Specification shall apply to epoxy grout, epoxy mortar and epoxy concrete for traffic and non-traffic bearing applications. Epoxy grout/mortar/concrete shall consist of an epoxy bonding agent and an aggregate component.

Prepackaged epoxy grout/mortar/concrete shall be prepared from a ready-to-mix epoxy bonding agent/aggregate system supplied by a manufacturer in kit form.

Non-prepackaged epoxy grout/mortar/concrete shall be prepared from an epoxy bonding agent and an aggregate component that is clean, surface dry and inert and that is of a quality and gradation suitable for Portland cement mortar or concrete. Aggregate meeting the requirements of Section 9-03.1(2) will be satisfactory. Epoxy grout/mortar/concrete for patching external concrete shall be concrete-gray in color.

**9-26.3(1)A TRAFFIC BEARING APPLICATIONS**

Epoxy grout/mortar/concrete for traffic bearing applications shall have a seven-day compressive strength of not less than 2500 psi when tested in accordance with ASTM C579. Epoxy bonding agent shall be Type III as described in Section 9-26.1(1)C.

**9-26.3(1)B NON-TRAFFIC BEARING APPLICATIONS**

Epoxy grout/mortar/concrete for non-traffic bearing applications shall have a seven-day compressive strength of not less than 4000 psi when tested in accordance with ASTM C579. Epoxy bonding agent shall be Type I, II, IV, or V as appropriate for intended use as described in Section 9-26.1(1)A and Section 9-26.1(1)B.

**9-26.3(2) PACKAGING AND MARKING**

Packaging and Marking of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(2).

**9-26.3(3) CERTIFICATION**

Certification of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(3).

**9-26.3(4) REJECTION**

Rejection of the epoxy bonding agent component of epoxy grout/mortar/concrete shall meet the requirements of Section 9-26.1(4).

**9-26.3(5) ACCEPTANCE**

Acceptance of the epoxy grout/mortar/concrete material for use on the project shall be based on a passing test report from the Materials Laboratory.

**SECTION 9-27 CRIBBING****9-27.1 RESERVED****9-27.2 RESERVED****9-27.3 GABION CRIBBING****9-27.3(1) GABION FABRIC**

Gabions may be fabricated from either hexagonal twisted wire mesh or from welded wire mesh. Only one type of mesh and protective coating shall be used throughout a structure.

Baskets shall be furnished in the required dimensions with a dimensional tolerance of  $\pm 5\%$ .

Wire for construction of gabions shall be either galvanized steel wire conforming to ASTM A 641, Class 3, Soft Temper, or aluminized steel wire conforming to ASTM A 809, Soft Temper. The wire shall have a minimum tensile strength of 60,000 psi when tested in accordance with ASTM A 370.

**9-27.3(2) GABION BASKETS**

Gabion baskets 1 foot or greater in the vertical dimension shall have mesh openings with nominal dimensions not to exceed 4-1/2 inches and the maximum area of any mesh opening shall not exceed 10 square inches.

1. Hexagon Twisted Wire Mesh

- a. Wire for galvanized or aluminized hexagonal twisted wire mesh shall be nominal sized 0.120 inch galvanized steel wire or aluminized steel wire.
  - b. Hexagonal wire mesh be formed from galvanized or aluminized wire in a uniform hexagonal pattern with nonraveling double twist. The perimeter edges of the mesh for each panel shall be tied to a selvage wire of the same composition as the body mesh and have a minimum diameter of 0.150 inch so that the selvage is at least the same strength as the body of the mesh.
2. Welded Wire Mesh
- a. Welded wire mesh shall be fabricated from galvanized steel wire having a diameter of 0.106 inch. Wire shall be galvanized prior to fabrication.
  - b. Welded wire mesh shall be formed in a uniform square pattern with openings 3 inches by 3 inches with a resistance weld at each connection in accordance with ASTM A 185.
  - c. If required, a PVC coating shall be fusion bonded onto the welded wire mesh to provide a nominal coating thickness of 0.0216 inch per side with a minimum of 0.0150 inch.
3. PVC Coating (for welded wire mesh only).
- Acceptance of PVC coating material shall be by certified test reports of an independent laboratory. The initial properties of PVC coating material shall have a demonstrated ability to conform to the following requirements:
- a. Specific Gravity — In the range of 1.2 to 1.4, when tested according to ASTM D 792.
  - b. Tensile Strength — Not less than 2,275 psi, when tested according to ASTM D 638.
  - c. Modulus of Elasticity — Not less than 1,980 psi at 100 Strain, when testing according to ASTM D 638.
  - d. Hardness — Shore "A" not less than 75 when tested according to ASTM D 2240.
  - e. Brittleness Temperature — Not higher than 15°F when tested according to ASTM D 746.
  - f. Resistance to Abrasion — The percentage of the mass loss shall be less than 12 percent when tested according to ASTM D 1242, Method B at 200 cycles, CSI-A Abrader Tape, 80 Grit.
  - g. Salt Spray Exposure and Ultraviolet Light Exposure — The PVC shall show no effect after 3,000 hours of salt spray exposure according to ASTM B 117. The PVC shall show no effect of exposure to ultraviolet light with test exposure of 3,000 hours using apparatus Type E and 63°C, when tested according to Practice D 1499 and Practice G 23. After the salt spray test and exposure to ultraviolet light as specified above, the PVC coating shall not show cracks, blister, split, nor show a noticeable change of color. In addition, the specific gravity, tensile strength, modulus of elasticity, and resistance to abrasion shall not change more than 6, 25, 25, and 10 percent respectively from their initial values.

### 9-27.3(3) GABION MATTRESSES

Gabion baskets less than 1 foot in the vertical dimension shall have mesh openings with nominal dimensions not to exceed 3.3 inches, and the maximum area of any mesh opening shall not exceed 6 square inches.

- 1. Hexagonal Twisted Wire Mesh:
  - a. Wire for galvanized or aluminized hexagonal twisted wire mesh shall be nominal sized 0.086 inch galvanized steel wire or aluminized steel wire.
  - b. Hexagonal wire mesh shall be formed from galvanized or aluminized wire in a uniform hexagonal pattern with nonraveling double twisted. The perimeter edges of the mesh for each panel shall be tied to a selvage wire of the same composition as the body mesh and have a minimum diameter of 0.1062 inch so that the selvage is at least the same strength as the body of the mesh.
- 2. Welded Wire Mesh:
  - a. Welded wire mesh shall be fabricated from galvanized steel wire having a diameter of 0.080 inch. Wire shall be galvanized prior to fabrication.
  - b. Welded wire mesh shall be formed in a uniform rectangular pattern with openings 1-1/2 inches by 3 inches with a resistance weld at each connection in accordance with ASTM A 185.
  - c. If required, a PVC coating shall be fusion bonded onto the welded wire mesh to provide a nominal coating thickness of 0.0216 inch per side with a minimum of 0.0150 inch. The PVC coating shall be in conformance with Section 9-27.3(2).

### 9-27.3(4) FASTENERS FOR BASKET ASSEMBLY

The lacing wire shall be a nominal sized 0.0866 inch galvanized steel wire or aluminized steel wire. Lacing wire shall have the same coating as the basket mesh.

Spiral binders, if used for joining welded wire panels shall be formed from 0.106 inch nominal diameter steel wire with a 3 inch pitch having the same specifications and coating as the wire mesh. Lacing wire may be used in lieu of spiral binders.

Alternate fasteners for basket assembly shall remain closed when subjected to a 600 pound tensile force when confining the maximum number of wires to be confined. Installation procedures and test results for alternate fasteners shall be submitted for approval.

Internal connecting wires shall be the same as required for lacing wire. Alternate stiffeners acceptable to the gabion manufacturer may be used if found acceptable to the Engineer.

### 9-27.3(5) NONRAVELING CONSTRUCTION

The wire mesh shall be fabricated in a manner to be nonraveling. This is defined as the ability to resist pulling apart at any of the connections forming the mesh when a single strand in a section of mesh is cut.

**9-27.3(6) STONE**

Stone for filling gabions shall have a Degradation Factor of at least 30. The stone shall be dense enough to pass the unit-weight test described in Section 6-09.3(6)F. Stone shall meet the following requirements for gradation:

SIEVE SIZE	PERCENT PASSING
8" square	100
6" square	75-90
4" square	0-10
% Fracture	75 min.

All percentages are by weight.

**SECTION 9-28 SIGNING MATERIALS AND FABRICATION****9-28.1 SIGNS****9-28.1(1) GENERAL**

Signs to be mounted on wood utility poles (other than Seattle City Light poles) and signs installed overhead shall be aluminum. Other signs shall be either High Density Overlay plywood or sheet aluminum.

Parking and pedestrian control signs shall be nonreflectorized. All other traffic signs shall be reflectorized.

STOP and YIELD sign backs and edges shall be painted with one coat of red enamel to match the red on the sign face.

Regulatory and warning signs shall have rounded corners with the exception of STOP signs. All other signs shall have square cut corners. Borders for signs having square cut corners shall have a corner radius approximately 1/8 of the lesser side dimension of the sign up to a maximum radius of 12 inches. For signs with rounded corners, the borders shall be concentric with the rounded corners.

**9-28.1(2) PLYWOOD**

Plywood signs shall be constructed of High Density Overlay plywood, meeting the requirements of "Products Standard PS 1-83 for Softwood Plywood, Construction and Industrial" published by the Product Standards Section of the U.S. Department of Commerce. The plywood shall be free of contaminants which would adversely affect the application or life of the sheeting to be applied. Face veneers shall be Grade B or better.

Core and crossband veneers shall be solid. Core veneers shall be jointed, and core gaps shall not exceed 1/8 inch in width. The entire area of each contacting veneer surface shall be bonded with a waterproof adhesive that meets the requirements of the U.S. Department of Commerce for exterior type plywood.

The overlay shall be of the high density type. It shall have a minimum weight of 60 pounds per thousand square feet of surface and shall be at least 0.012 inches thick before pressing. The overlay shall have a sufficient resin content to bond itself to the plywood, with a minimum resin content of 45 percent based on the dry weight of the impregnated fiber.

Thickness - Single Panel Plywood Signs:

Up to 18 inches inclusive in width	3/8 inch
Over 18 inches to 36 inches inclusive in width	5/8 inch
Over 36 inches in width	¾ inch
Overhead signs	¾ inch

Street designation signs and signs mounted on span wires or mast arms shall have the sign back and edges primed with 1 coat of white exterior enamel undercoat and finished with 1 coat of International Green (Forest Green) exterior enamel. All other plywood signs shall have only the edges primed with 1 coat of white exterior enamel undercoat and finished with 1 coat of white exterior enamel. The primer shall be as recommended by the Supplier of the finish coat. The finish enamel shall meet the requirements of Federal Specification TT-E-489.

**9-28.1(3) SHEET ALUMINUM SIGNS**

Sheet aluminum signs shall be constructed of Material conforming to ASTM B209, alloy 6061T6, or alloy 5052-H36 or H38. Alloy 50D5-H34 may be used for sign refacing.

After the aluminum sheet panel has been fabricated, the surface of each panel shall be protected from corrosion. The corrosion protection shall meet the requirements of ASTM B-449 Class II Specification for Chromates on Aluminum. Aluminum signs over 12-feet wide by 5-feet high shall be comprised of vertical panels in increments of 2, 3, or 4-feet wide. No more than one 2-foot and/or 3-foot panel may be used per sign. The Contractor shall use the widest panels possible. All parts necessary for assembly shall be constructed of aluminum, galvanized steel, or stainless steel in accordance with the Plans. Sheet thickness shall be as follows:

MAXIMUM HORIZONTAL DIMENSION	SHEET ALUMINUM THICKNESS
---------------------------------	-----------------------------

Overlay panels	0.050-inch
Up to 20-inches	0.063-inch
20-inches to 36-inches, inclusive	0.080-inch
Over 36-inches (Permanent Signs)	0.125-inch

The side dimension for a diamond shaped warning sign is considered to be the maximum horizontal dimension.

Before placing aluminum in contact with untreated steel, the steel surfaces shall be protected by proper cleaning and painting with one coat of paint conforming to Section 9-08.2 Item 3 Formula A-9-73 and two coats of aluminum paint.

Metal shall be handled by device or clean canvas gloves between all cleaning and etching operations and the application of reflective sheeting.

Sheet aluminum edges shall be filed smooth to eliminate sharp edges and burrs.

#### **9-28.1(4) REFLECTIVE SIGN FACE SHEETING**

Reflective sheeting shall consist of spherical lens elements embedded within a transparent plastic or adhered to a synthetic resin and encapsulated by a transparent plastic. The sheeting shall have a flat, smooth outer surface, be weather resistant, and have a pre-coated adhesive backing with a protective liner.

The sheeting shall have the following minimum brightness values expressed as average candle power per foot candle per square foot of Material. Measurements shall be conducted in accordance with standard testing procedures for reflex-reflectors in Federal Specification L-S-300.

The brightness of the reflective sheeting, totally wet by rain, shall be not less than 90 percent of the above values. Wet performance measurements shall be conducted in conformance with the Standard Rainfall Test specified in Federal Specification L-S-300C.

The diffuse day color of the reflective sheeting shall be visually evaluated by comparison with the applicable Highway Color Tolerance Chart. Color comparisons shall be made under north daylight or a scientific daylight having a color temperature of from 6500 degrees to 7500 degrees Kelvin. Color shall be illuminated at 45 degrees and viewed at 90 degrees.

The sheeting surface shall be smooth and facilitate cleaning and wet performance and exhibit 85 degree glossmeter rating of not less than 50 (ASTM D 523). The sheeting surface shall be readily processed and compatible with transparent and opaque process colors and show no loss of the color coat with normal handling, cutting, and application. The sheeting shall permit cutting and color processing at temperatures of 60°F to 100°F and 20 to 80 percent relative humidity.

The sheeting surface shall be solvent resistant such that it may be cleaned with gasoline, VM&P Naptha, mineral spirits, turpentine, methanol, or xylol.

The embedded lens sheeting, when applied according to manufacturer's recommendations to cleaned and etched 0.020 inch x 2 inch x 8 inch aluminum, conditioned 24 hours, and tested at 72°F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 3/4 inch diameter mandrel.

Conditioned for 48 hours, the tensile strength of the embedded lens sheeting shall be 5 to 20 pounds per inch width when tested in accordance with ASTM D 828. Following liner removal, the sheeting shall not shrink more than 1/32 inch in 10 minutes nor more than 1/8 inch in 24 hours in any dimension per 9 inch square at 75°F and 50 percent relative humidity.

The encapsulated lens sheeting, with liner removed, conditioned for 24 hours at 72°F and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 1/8 inch diameter mandrel with adhesive side contacting the mandrel.

The protective liner attached to the adhesive shall be easily removable by peeling without soaking in water or other solvents.

The pre-coated adhesive backing shall be a tack free heat activated type or a pressure sensitive type, either of which shall adhere to the sheeting without the necessity of additional coats of adhesive.

The adhesive shall form a durable bond to smooth the corrosion-resistant and weather-resistant surfaces and permit the reflective sheeting to adhere securely 48 hours after application at temperatures of 30°F to 200°F. The adhesive bond shall be sufficient to render the applied sheeting vandal-resistant and prevent its shocking off when jabbed with a spatula at 10°F. The sheeting shall resist peeling from the application surface when a 5-pounds per inch width force is applied as outlined in ASTM D 903.

WITH EMBEDDED LENS ELEMENTS:									
	DIV. ANG.			DIV. ANG.			DIV. ANG.		
	0.2deg	0.5deg	1.50	0.2.	0.5deg	1.5deg	0.2deg	0.50	1.5deg
INC. ANG.	SILVER-WHITE #1			SILVER-WHITE #2			YELLOW		
-4deg	70.0	30.0	4.0	80.0	41.0	4.0	50.0	25.0	5.0
40deg	14.5	8.5	1.5	16.5	9.5	2.0	11.5	7.0	1.5
INC. ANG.	RED			BLUE			GREEN		
-4deg	14.5	7.5	1.0	4.0	2.0	0.6	9.0	4.5	1.0
40deg	3.0	1.5	0.3	0.9	0.4	0.08	1.8	1.5	0.2
INC. ANG.	ORANGE			BROWN			-----		
-4deg	25.0	13.5	1.5	1.0	0.35	0.1			
40deg	1.0	0.8	0.1	0.2	0.1	0.01			

WITH ENCAPSULATED LENS ELEMENTS:						
	Div. Ang.			Div. Ang.		
	0.2deg	0.5deg	1.5deg	0.2deg	0.5deg	1.5deg
INC. ANG.	SILVER WHITE			YELLOW		
-4deg	250.0	95.0	4.0	170.0	62.0	3.0
40deg	120.0	54.0	2.0	80.0	35.0	1.5
INC. ANG.	ORANGE			GREEN		
-4deg	70.0	25.0	1.1	30.0	12.0	0.5
40deg	33.0	14.0	0.5	14.0	6.8	0.2
INC. ANG.	RED			-----		
-4deg	35.0	13.0	0.7			
40deg	16.0	7.4	0.3			

**9-28.1(5) NON-REFLECTIVE SIGN FACE SHEETING**

The non-reflective sheeting shall consist of a white plastic film having a smooth, flat outer surface. The sheeting shall be weather-resistant and have a protected pre-coated adhesive backing.

**9-28.1(6) SHEETING APPLICATION**

Plywood sign faces shall be cleaned with lacquer thinner, heptane, benzene, or solvent recommended by the sheeting manufacturer. The surface shall be sanded with light sandpaper or steel wool and wiped dry and clean with clean cloth. Aluminum sign faces shall be cleaned with a solvent recommended by the sheeting manufacturer.

Sign face sheeting shall be applied by a vacuum applicator recommended by the sheeting manufacturer, or by a continuous roll applicator.

Heat-activated adhesive backed sheeting shall be applied by the vacuum method. The adhesive on the back of the sheeting shall be activated by a minimum temperature of 185°F and with a minimum vacuum pressure of 25 inches of mercury. This operation shall be in effect for a minimum of 3 minutes on plywood and 5 minutes on metal. After aging for 48 hours at 75°F, the adhesive shall form a bond equal to or greater than the strength of the sheeting.

Pressure sensitive adhesive backed sheeting shall be applied by a continuous roll applicator. The process shall be in conformance with the recommendation of the sheeting manufacturer.

Edges and splices of sign face sheeting shall be coated with an edge sealer recommended by the sheeting manufacturer.

**9-28.1(7) LETTERS, ARROWS, AND SYMBOLS**

Letters, arrows, and symbols shall be of the type, size, and color specified on the Drawings, in the Specifications or WSDOT Sign Fabrication Manual, and the "Standard Highway Signs" by United States Department of Transportation.

Letters, arrows, and symbols shall be of Material compatible with the sign surface Material, as recommended by the sign surface manufacturer or approved by the Engineer.

**9-28.1(8) HARDWARE**

Bolts, nuts, and washers shall be of the same Material for each attachment. All parts necessary for assembly shall be constructed of the following Materials:

HARDWARE	SPECIFICATION
Bolts	ASTM B 209, 2024-T4 Aluminum
	ASTM A 307 Steel
	ASTM F 593 Stainless Steel
Washers	ASTM B 209, 2024-T4 Aluminum
	ASTM A 36 Steel
	ASTM A 240 Stainless Steel
Nuts	ASTM B 209, 6061-T6 Aluminum
	ASTM A 307 Steel
	ASTM F 594 Stainless Steel
Locknuts	ASTM B 211, 2017-T4 Aluminum
	ASTM A 307 Steel
	ASTM F 594 Stainless Steel
Rivets	ASTM B 209, 6061-T6 Aluminum
	ASTM B 316, 6053-T61 Aluminum
Post Clips	ASTM B 179, 356-T6 Aluminum
Wind Beams	ASTM B 209, 6061-T6 Aluminum
Angle and Z-Bar	ASTM B 209, 6061-T6 Aluminum
	ASTM A 36 Steel
Strap and Mounting Bracket	ASTM A 276 Stainless Steel

All steel parts shall be galvanized per ASTM A 123. Steel bolts and related connecting hardware shall be galvanized per ASTM A 153.

**9-28.2 POSTS****9-28.2(1) RESERVED****9-28.2(2) PARKING METER POST****9-28.2(2)A GENERAL**

Parking meter post mounted with a parking meter and with no sign attached to the post shall have a 2-1/2 inch nominal ASTM A 53, Schedule 40 galvanized standard steel pipe sleeve fitted loosely over the exposed meter post full length. On the bottom, the sleeve shall make contact with the canopy for surface mounted posts or with the finished grade for direct burial posts. On the top, the sleeve shall make contact with the parking meter base. Standard Plan no. 629 shows the sleeve on a direct burial post. Direct burial and surface-mounted meter posts not used for a parking meter and used only for parking sign or other type sign, shall have a 2-3/8 inch galvanized steel cap securely fitted over the top of the post as shown on Standard Plan nos. 627 and 628.

**9-28.2(2)B DIRECT BURIAL PARKING METER POST**

See Standard Plan no. 629. Direct burial parking meter post shall be fabricated from 2 inch nominal diameter standard ASTM A 53, schedule 40 galvanized pipe, 46 inches in length, and with the bottom 3 inches flattened. Two 1/4 inch weep holes are required. The buried post base shall be backfilled, and mounded for drainage, with very quick setting and very strong cement grout, such as "jet-set cement", having the following properties:

Compressive Strength	ASTM C 109	8,000 psi. min. in 28 days
Bond Strength	ASTM C 1042	500 psi. min. in 1 day
Shrinkage	ASTM C 596	Less than 0.10%
Set-time	ASTM C 191	Initial set in 8 to 10 minutes Final set in 15 to 20 minutes

Cement grout meeting these requirements is "jet-set cement" and can be obtained from Jet Set Northwest Inc., Seattle, Wa., or approved equal.

**9-28.2(2)C SURFACE MOUNTED PARKING METER POSTS**

Bolted-down parking meter and parking sign posts shall be fabricated from 2 inch nominal diameter standard ASTM A 53, schedule 40 galvanized steel pipe, 40 inches in length, with 5/16 x 5 x 5 inch ASTM A 36 steel base plate. The meter post base "canopy", also known as "collar", shall be made of 0.062 inch 2-5-0 aluminum as shown on Standard Plan no. 627.

**9-28.2(3) TELESAR QWIK-PUNCH SIGN POST AND POST ANCHOR**

Unless otherwise specified, Sign Posts shall be Telespar Qwik-Punch®, Tube Size 2-inches by 2-inches, Gauge 14. Unless otherwise specified, the length of the post shall be specified in the Standard Plans with a length tolerance of +/- 0.25 inch. The finished members shall be straight and have a smooth uniform finish. Post shall be in-line galvanized per AASHTO M-120.

Unless otherwise specified, Light Duty and Heavy Duty Post Anchors shall be Telespar Qwik-Punch®, one size larger than the sign post, with gauge and length as specified on Standard Plan 621b.

Surface Mounted Post Anchors shall be gauge 12 Telespar Qwik-Punch® galvanized tube welded to a ¼-inch thick, 7-inch by 7-inch steel base plate. Four, ¾-inch holes shall be drilled in the base plate, one at each corner centered 1.06-inches from each edge of the plate; centered 4.88 inches apart. The tube length as specified on Standard Plan 621b, one size larger than the sign post. The tube shall be tube centered on the plate as shown on Standard Plan 621b and fillet welded on all four sides where the tube meets the plate. All welds shall develop the full strength of the parent metal. After fabrication, the base plate and welds of the anchors shall be hot-dip galvanized in accordance with AASHTO M111 or ASTM 123. The tube portion of the anchors shall not be hot-dipped as not to impede the insertion of the sign post.

Telespar Qwik-Punch Sign Post and Post Anchor shall have 7/16-inch prepunched holes on 1-inch centers.

Corner bolts, nuts, and washer for attaching post to anchors shall be Telespar recommended. Surface mounting bolts shall be as shown on Standard Plan 621b.

**9-28.2(4) STREET NAME SIGN POST**

Street name sign post shall be 2-1/2 inch inside diameter x 10 feet 6 inches standard weight galvanized steel pipe, with the bottom 6 inch end section flattened to form a wedge. For details, see Standard Plan no. 622.

**9-28.3 RESERVED****SECTION 9-29 PAVEMENT MARKING****9-29.1 GENERAL**

Materials for pavement markings shall be paint or plastic Material as specified in the Contract.

**9-29.2 PAINT****9-29.2(1) GENERAL**

Paint shall comply with Specifications for no heat, instant dry pavement marking. White sharp sand shall comply with the Specifications for E-16 sand.

**9-29.2(2) PHYSICAL PROPERTIES OF THE COATING**

1. Viscosity (in Krebs Units).
  - a. At 70°F - 70-75 KU
  - b. At 50°F - 86 KU max.
  - c. At 122°F - 66 KU min.
2. Weight per gallon at 70°F.
  - a. White 12.00 pounds min.
  - b. Yellow 12.10 pounds min.
3. Contrast ratio at spread rate of 320 sq. ft. per gallon.
  - a. White .92 min.
  - b. Yellow .92 min.
4. Daylight reflectance (at 10 mils wet film thickness).
  - a. White 86 min.
  - b. Yellow 64 min.
5. Non-volatile content (total at 212°F.) - 65% to 68%.
6. Pigment content of total weight - 53% max.
7. Dispersion, Hegman standard gauge - 2 min.
8. Flexibility - Pass 1/2-inch mandrel bend.
9. Dry to no-pick-up (beaded) - 15 to 35 sec.
10. Bleeding over asphalt - 90% min.
11. The Material shall not show evidence of heavy caking or settling which requires mechanical means to return the product to usable condition for a period of one year from the date of manufacture or date first shipped to the Owner.
12. Color - The paint shall match a standard color sample which may be obtained upon application to the SPU Materials Laboratory.

**9-29.2(3) TEST METHODS**

The properties enumerated in these Specifications shall be determined in accordance with the following methods of test:

1. Viscosity - Federal test method standard 141A, Method #4281.



2. Weight per gallon - Federal test method standard 141A, Method #4184.1.
3. Contrast ratio - Federal test method standard 141A, Method #4121 procedure "B", method "B".
4. Daylight reflectance - Federal test method standard 141A, Method #6121 using standards as prescribed in Par. 1.3.2.
5. Non-volatile content - Federal test method standard 141A, Method #4021.1.
6. Pigment content - Federal test method standard 141A, Method #4021.1.
7. Dispersion - Federal test method standard 141A, Method #4411.1.
8. Flexibility - The paint shall show no cracking, flaking, or loss of adhesion when tested in the following manner:
9. Apply a wet film thickness of .005 inches with a film applicator to a 3 x 5 tin panel weighing 0.39 to 0.51 lbs. per square foot previously cleaned with benzene and lightly buffed with steel wool. Dry the paint film at 70°F to 80°F in a horizontal position for 18 hours, then bake in an oven 3 hours at 212°F ± 4°F. Cool to room temperature for at least 1/2 hour and bend over a 1/2 inch diameter rod and examine.
10. Dry to no-pick-up - The reflectorized line, when applied at a rate of 10 mils wet film thickness and 4 pounds of glass spheres per gallon of paint, shall dry to no-pick-up in 15 to 35 seconds. For test purposes, the line shall be applied using a striper with accurate thickness control capable of maintaining a uniform thickness with 4 pounds of glass spheres per gallon either dropped or blown onto the stripe. The line shall be dry to no-pick-up within specified time range when the pavement temperature is 55°F or more and the relative humidity is 50 percent or less, providing that the pavement is dry. Dry to no-pick-up tests will be performed by having a standard size sedan or equivalent test vehicle, coast across the paint stripe (no turning or accelerating). A successful no-pick-up test will be considered one in which at least 3 out of 4 samples show no visible paint from the stripe being tracked onto the adjacent pavement when viewed standing 50 feet from the point where the test vehicle crosses the stripe. All paint samples shall have successfully completed all laboratory tests prior to the no-pick-up test being performed. All field testing shall be performed blind in that the persons conducting the field test shall have no knowledge of which sample is from which manufacturer. All testing shall be performed without the manufacturer's representatives present. Each manufacturer will be provided test results for their sample(s) upon request.
11. Bleeding over asphalt - ASTM D 969 using substrate as in Par. 3.2 except reflectance measurement over asphalt paper area is compared to reflectance measurement over taped area.
12. Reflectance over asphalt paper area X 100 = % Bleeding Reflectance over taped area or asphalt.

#### 9-29.2(4) COMPOSITIONAL REQUIREMENTS

1. **Pigment Composition:** Pigments shall be first quality point grade pigments. Medium chrome yellow for the yellow traffic paint shall meet the requirements of ASTM D 211-67, Type III. The Titanium Dioxide for the white traffic paint shall meet the requirements of ASTM D 476-73 Type II, III or IV. The inert or filler pigments shall be of a type and quality generally recognized as first quality paint grade products and shall not contribute to settling of the paint in storage or be so hard as to cause excessive wear of the spray application equipment.
2. **Vehicle or Resinous Binder Composition:** The vehicle may be any combination of natural or synthetic resinous Materials. Chlorinated rubber combined with other natural and/or synthetic resins and plasticizers is the preferred system. All resins used shall be permanently capable of re-dissolving in the solvent combination used in the paint. Therefore, resins which dry by the process of oxidation and/or polymerization such as alkyd resins are specifically excluded as suitable resinous binders in this Specification. The purpose of the above requirement is to minimize build-up of the paint on the sides of tanks, paint lines, and clogging of spray equipment from undissolvable skins.

#### 9-29.3 THERMOPLASTIC

One of the following types of thermoplastic pavement marking Material Types "A" or "B" shall be used at the Contractor's option and in compliance with the manufacturer's recommendations:

**Type "A":** Hot-laid, liquid thermoplastic Material, containing reflective glass bead (with additional glass beads applied separately), 125 mil thickness. A thickness tolerance not exceeding 10-percent will be allowed. The approved thermoplastic Material Suppliers are as follows:

1. Lafrentz brand, 125 mil thickness, hot extruded thermoplastic manufactured by Lafrentz Road Services Ltd., Edmonton, Alberta, Canada T6E4N7, or
2. Catatherm ABITOL formulation, 125-mil thickness, hot extruded thermoplastic manufactured by Ferro Corporation, Cataphote Division, P.O. Box 2369, Jackson, Mississippi 39205, or
3. M.L.E. Code #R200/80 formulation, 125-mil thickness, hot extruded thermoplastic manufactured by M.L.E. Industries Ltd., Calgary, Alberta, Canada T2C1N6, or
4. Pave-Mark SD formulation, 125-mil thickness, hot extruded thermoplastic manufactured by Pave-Mark Corporation, Smyrna, Georgia 30081.

**Type "B":** Pre-formed fused thermoplastic

Type B material consists of a mixture of pigment, fillers, resins and glass beads that is factory produced in sheet form. The material is applied by heating the pavement and top heating the material. The material shall contain intermixed glass beads. The material shall conform to ASSHTO M249, with the exception of the relevant differences for the materials being applied in the pre-formed state and the following:

**Resin** – The resin shall be alkyd or hydrocarbon.

The sample material submitted for approval shall be fused to a suitable substrate prior to performing the following tests.

**Retroreflectance** – ASTM E 1710

The fused samples shall have a minimum initial coefficient of retroreflective luminance of 250 mcd-m<sup>-2</sup>-lx<sup>-1</sup> for white and 175 mcd-m<sup>-2</sup>-lx<sup>-1</sup> for yellow in accordance with ASTM E 1710 when measured with a 30-meter retroreflectometer. The owner will measure retroreflectivity for compliance with a Delta LTL-X retroreflectometer.

**Skid Resistance** – ASTM E 303

45 BPN units minimum

The blue color shall match Federal Standard 595, color number 35180, and the tolerance of variation shall match that shown in the FHWA "Highway Blue Color

The red color shall match Federal Standard 595, color number 11136, and the tolerance of variation shall match that shown in the FHWA "Highway Red Color Tolerance Chart".

The glass beads shall comply with Specifications for Type I waterproof overlay glass spheres.

#### 9-29.4 PRESSURE-SENSITIVE TAPE

Pressure-sensitive tape shall be a 4 inch wide, pressure-sensitive, reflective-type tape of the form suitable for marking asphalt and concrete pavement surfaces. Biodegradable tape with paper backing is unacceptable.

The following pressure-sensitive tape has been approved as a temporary pavement marking tape:

3-M Scotch name brand pavement marking tape, coated with pressure-sensitive adhesive, manufactured by 3-M Company, 3-M Center, St. Paul, Minnesota 55101.

Surface preparation and application shall be in conformance with all the manufacturer's specifications.

#### 9-29.5 TYPE D - LIQUID COLD APPLIED METHYL METHACRYLATE

Type D material consists of a two part mixture of methyl methacrylate and a catalyst that is applied cold to the pavement. The material can be applied at a continuously uniform thickness or it can be applied with profiles (bumps). The material is classified by Type designation, depending upon the method of application.

Glass beads shall conform to the manufacturer's recommendations necessary to meet the retroreflectance requirements. Type D-1, D-2, D-3, D-4, and D-6 material shall have intermixed glass beads in the material prior to application.

Type D-5 material shall have glass beads injected into the material at application and a second coating of top dressing beads applied immediately after material application. Type D materials shall conform to the following:

Type D materials shall conform to the following:

Type D – Liquid Cold Applied Methyl Methacrylate Properties					
Property	Test Method	White		Yellow	
		Min.	Max.	Min.	Max.
Adhesion to PCC or HMA, psi	ASTM 4541 <sup>1</sup>	200 or substrate failure		200 or substrate failure	
Chemical Resistance	<sup>2</sup>	No Effect		No Effect	
Hardness	ASTM D 2240 <sup>3</sup>	50		50	
No Track Time	ASTM D 711 <sup>4</sup>		30		30
Skid Resistance, BPN	ASTM E 303	45		45	
Tensile Strength, psi	ASTM D 638	125		125	

<sup>1</sup>Part A and B mixed, applied at 60 mils thickness.

<sup>2</sup>Cured markings shall be resistant to calcium chloride, sodium chloride, fuels, oils, and UV effects. Cure three days for motor oil, gas, diesel, ATF, salt, and anti-freeze.

<sup>3</sup>Shore Durometer Type D and measurement made after 24 hours.

<sup>4</sup>Sample applied at 40 mils.

Type D liquid cold-applied methyl methacrylate shall meet the following formulations:

##### 4:1 Formulation Type D – Liquid Cold Applied Methyl Methacrylate

Type D-1 – One-gallon of methyl methacrylate and 3-fluid ounces of benzoyl peroxide powder (by weight).

Type D-2, D-3, D-4, and D-5 – Four parts methyl methacrylate and one part liquid benzoyl peroxide (by volume).

##### 98:2 Formulation Type D – Liquid Cold Applied Methyl Methacrylate

Type D-5– Ninety-eight parts methyl methacrylate and two parts liquid benzoyl peroxide (by volume).

D liquid cold applied methyl methacrylate shall meet the following requirements for viscosity:

4:1 Formulations Type D – Liquid Cold Applied Methyl Methacrylate					
Property	Test Method	D-5 White		D-5 Yellow	
		Min.	Max.	Min.	Max.
Viscosity cP @ 77°F, 50-rpm, spindle #4	ASTM D 2196 Method B, LV Model	5,000	8,000	7,000	11,000

98:2 Formulations Type D – Liquid Cold Applied Methyl Methacrylate			
Property	Test Method	D-5	
		Min.	Max.
Viscosity cP @ 77°F, 50-rpm, spindle #4	ASTM D 2196, Method B, LV Model	100	118

## SECTION 9-30 WATER DISTRIBUTION AND TRANSMISSION MATERIALS

### 9-30.0 GENERAL

All Materials for water distribution and transmission shall be new. Materials used for temporary Water Main and for temporary service connection purposes may be either new or previously used materials and shall be subject to Seattle Public Utilities' Water Operation's inspection and approval prior to installation.

Prior to ordering any pipe to be used in a potable water supply, the Contractor shall submit the Material source as required by Section 1-06.1 and shall obtain the Engineer's approval.

All direct and indirect drinking water system components which come in contact with potable water shall have National Sanitation Foundation certification.

### 9-30.1 PIPE

All pipe and fittings shall be clearly marked with the manufacturer's name, type, class, and thickness as applicable and shall be marked on the component at the place of manufacture. Marking shall be legible and permanent under normal conditions of handling and storage.

#### 9-30.1(1) DUCTILE IRON PIPE

1. Ductile iron pipe shall be centrifugally cast in 18 or 20 foot nominal lengths and shall be marked conforming to AWWA C151. Ductile iron pipe shall have a double thick cement-mortar lining conforming to AWWA C104. Ductile iron pipe shall be Standard Thickness Class 52. Flanged ductile iron pipe shall be CL 53 per AWWA C115. Thicker Classes are acceptable.
2. Non-restrained joints shall be rubber gasket, push-on type, or mechanical joint conforming to AWWA C111.
3. Restrained joints shall be as specified in Section 9-30.2(6).
4. Special coatings shall comply with Section 9-30.1(6).
5. Ductile Iron pipe shall meet SPU's taste and odor test requirements.

#### 9-30.1(2) RESERVED

#### 9-30.1(3) RESERVED

#### 9-30.1(4) STEEL PIPE

##### 9-30.1(4)A STEEL PIPE LESS THAN 4 INCHES DIAMETER

Steel pipe less than 4 inches in diameter shall conform to ASTM A 53, schedule 40 and shall be hot dip galvanized inside and out, including the couplings. The pipe sections shall be coupled by malleable iron screw coupling in accordance with ANSI Specification B16.3.

##### 9-30.1(4)B STEEL PIPE 4 INCH DIAMETER AND LARGER

Steel pipe 4 inches in diameter and larger shall conform to AWWA C200. The type of protective coating and lining and other supplementary information required by AWWA C204 will be included in the Contract.

#### 9-30.1(5) PLASTIC PIPE AND ASBESTOS CEMENT PIPE

Polyvinyl chloride (PVC), polyethylene, polybutylene, and asbestos cement material pipe shall not be used as Water Main to convey potable water.

#### 9-30.1(6) PIPE COATINGS

##### 9-30.1(6)A SPECIAL PIPE COATINGS

Special pipe coatings shall be in accordance with the Contract.

### **9-30.1(6)B MULTI-LAYERED POLYETHYLENE TAPE COATING (MULTI-LAYERED POLYETHYLENE ENCASEMENT)**

See Section 9-30.1(6)D for polyethylene (film wrap) encasement.

Acceptable Suppliers of multi-layered polyethylene tape coating shall be Polyken YGIII as manufactured by Kendall Company, or Tapecoat CT 10/40 W as manufactured by Tapecoat Company, or approved equal. The multi-layered polyethylene tape coating shall conforming to AWWA C214, and shall meet the following requirements:

1. The multi-layered polyethylene tape coating system shall consist of the following components:
  - a. One layer of pipeline coating primer and 20 mil inner wrap.
  - b. One layer of pipeline wrap coating, 30 mils minimum thickness.
  - c. One additional layer of outer wrap coating, 30 mils minimum thickness.
2. The primer shall be fast drying and shall form an instantaneous, firm bond when the adhesive on the tape coating comes in contact with the primed pipe surface. Coating primer shall be compatible with the adhesive and shall be from the same manufacturer.
3. The inner wrap coating shall consist of polyethylene backing with a butyl-based adhesive laminated to one side of the backing. The polyethylene backing and adhesive shall be made by the calendaring process in order to ensure the maximum bonding of the adhesive to the backing. The adhesive shall be formulated so that it forms a firm bond upon contact with the primed pipe surface.
4. The pressure sensitive adhesive outer wrap shall consist of a polyethylene backing with a butyl-adhesive laminated to one side of the backing. The pressure sensitive adhesive on the outer wrap shall form a firm continuous bond to the backing of the tape coating.
5. Cutbacks on the spigot end shall be 6 inches or less and shall be made with a cutting device that is guided from the end of the pipe to ensure a straight, uniform cutback. No cutback shall be made on the bell end of the pipe.
6. Following the application of the outer wrap, the coating shall be electrically tested for holidays with a pulse tape holiday detector. The detector voltage range for this coating is 7000-9800 volts. The testing shall conform to NACE RP-02-74.  
All defects electrically detected shall be repaired by priming and patching with a suitable primer and tape as specified by the manufacturer and approved by the Engineer.
7. Accessory Tape. Accessory tape for fittings and specials shall be YG III as manufactured by Kendall Co., or approved equal. The accessory tape shall conform to AWWA C209, and shall meet the following requirements:
  - a. One layer of pipeline coating primer and 50 mil inner wrap.
  - b. One layer of 35 mil outer wrap.

The primer shall be fast drying and shall form an instantaneous, firm bond when the adhesive on the tape coating comes in contact with the primed pipe surface.

The pressure sensitive adhesive outer wrap shall consist of a polyethylene backing with a butyl-adhesive laminated to one side of the backing. The pressure sensitive adhesive on the outer wrap shall form a firm continuous bond to the backing of the tape coating.

### **9-30.1(6)C THERMOPLASTIC POWDER COATING**

#### **9-30.1(6)C1 GENERAL**

The powdered thermoplastic Material shall consist of acid modified polyolefin elastomer to which any stabilizers, pigments, or other additives necessary to meet the performance requirements of this Specification have been added by extrusion compounding. The thermoplastic powder shall be suitable for factory application by fluid bed dipping, and or elastic/flock deposition method. For on-site application, other application methods such as controlled flame spraying are acceptable if carried out by an approved applicator. When applied to a substrate in accordance with the guidelines agreed by the manufacturers and approved applicators, the powder shall form a coating which meets or exceeds all requirements of this Specification.

#### **9-30.1(6)C2 QUALITY OF DUCTILE IRON PIPE**

Surface preparation, application and curing of powder coating, and testing and touch-up of coating shall be performed by an "experienced applicator". "Experienced applicator" shall be defined as having working knowledge of and experience with:

1. Surface preparation/blasting of ductile iron pipe,
2. Application and curing of thermoplastic powder coating,
3. Quality assurance testing including:
  - a. mil thickness measurement,
  - b. profile measurement,
  - c. anchor and adhesion testing,
  - d. holiday testing, and
  - e. temperature monitoring, and
4. manufacturer approved touch-up repairs.

**9-30.1(6)C3 SURFACE PREPARATION**

The pipe and fittings shall be prepared for coating by blasting the pipe surface to remove impurities and imperfections. The existing pipe surface profile shall not change by more than 2 to 3 mils. Preparation shall consist of the following:

1. Before blast cleaning, remove all visible grease, asphalt coating, oil, slag, burs, and other protrusions resulting in a smooth substrate conforming to curvature. When a solvent is used, all solvent residue shall be removed;
2. Bevel all sharp edges and corners;
3. Do not use steel shot or other non-angular blast material; and
4. Use clean, dry, oil-free air for nozzle blasting.

When surface preparation is complete and the surface is viewed without magnification, staining, oil, grease, dirt, dust, rust, pre-existing coating, loose oxides, and any other contaminant shall not be visible. The prepared Material shall be maintained clean for the coating.

**9-30.1(6)C4 APPLICATION OF POWDER COATING****Powder Coating**

PPA 571 thermoplastic powder coating, as manufactured by Plascoat Systems Limited or an approved equal.

**Masking and Plugging**

All masking, where required, shall be done using a high powder coating masking tape. The ends of pipe and fittings shall be plugged both during heating in the oven, and during the coating process to keep the interior mortar lining cooler and to keep the powder coating from passing beyond the groove where the gasket is to be installed in the bell end of the pipe or fitting.

**Preheating**

All parts shall be preheated to a maximum temperature of 240°F before coating is applied.

A Raytek RAYNGER ST SERIES noncontact infrared temperature measurement tool or similar device shall be used for determining coating temperature.

Preheating shall be done using a gas fired convection oven or equivalent.

**Coating With Electrostatic Deposition**

After the part has been preheated to the 240°F temperature followed by the powder application to the surface of the part using a corona powder coating discharge gun, a negative polarity is required and a voltage of 30kv is recommended. The powder is applied across the total surface of the part, taking care that the powder is applied in a level and homogenous build. The coating shall be applied to a dry film thickness of 20 to 25 mil and be totally free of holidays/pinholes.

It is then necessary to convey the part to the oven which shall be set between 285°F and 385°F in order to complete flowing out of powder.

The coating shall be smooth, even and free of runs, sags, streaks and overspray.

**Coating With Fluid Bed Dip System**

After the part has been preheated to 240°F, the part is then dipped into a fluidized bed of powder and left for a prescribed time to accomplish a coating thickness of 20 to 25 mil.

The part shall be conveyed to the oven for a complete flowing of the powder.

The coating shall be smooth, even, and free of runs, sags, streaks and overspray.

**9-30.1(6)C5 TESTING****Holidays**

After completing the coating process, the part shall be cooled to ambient temperature and then electrically tested for holidays with a Tinker & Rasor AP/S1 holiday detector or equivalent. The voltage should not exceed 6kv for a 25 mil coating. The testing shall conform to NACE RP-02-74. All defects electrically detected shall be repaired by the following method. Clean the area around the holiday/pinhole using mineral sprits, acetone or alcohol. Immediately after cleaning, heat should be applied to the coating surrounding the pinhole to re-melt and flow the coating over the holiday/pinhole repair.

**Thickness**

Each coated part shall be tested for coating thickness using an electronic coating thickness gauge such as Qua Nix 1500 or equivalent and the test results in accordance with Section 1-06.5 shall be submitted to the Engineer within 3 Working Days of the testing.

**9-30.1(6)C6 FIELD REPAIR AND TOUCH-UP**

Damaged coating or repair of cutback areas may be repaired after proper substrate preparation. Exposed substrate should be thoroughly cleaned of corrosion products and contamination to expose bare metal. Abrasive techniques (wire brush, sandpaper, sandblast, etc.) followed by cleaning with mineral sprits, acetone or alcohol are recommended. Immediately after cleaning heat should be applied to the coating adjacent to the damaged area to re-melt and flow the coating over the damaged area. If required, additional PPA571 powder may be added and melted to insure proper installation of a homogenous protective coating of sufficient thickness.

Major repairs (large areas) may require a specialized Subcontractor with proper training and equipment to complete a fault holiday-free field repair. If that Subcontractor or the Contractor determine, or if the Engineer determines, that the level of damage is such that a fault holiday-free repair cannot be attained, then the Contractor shall remove and replace the damaged item.

### 9-30.1(6)C7 MATERIAL REQUIREMENTS

#### Test Conditions

Unless otherwise specified in the Contract, the testing conditions shall be in accordance with ASTM D 3924 at standard Conditions: 73.5°F ±3.5°F°, 50% ±5% relative humidity.

#### Specific Gravity

Specific gravity of the powder thermoplastic coating Material shall be between 0.90 and 0.97. Specific gravity shall be determined in accordance with method B specified in ASTM D 729.

#### Color

Color of the thermoplastic powder coating shall be specified by the purchaser and evaluated for conformance in accordance with ASTM D 1729.

#### Flexibility

The thermoplastic powder coating shall exhibit no cracking, peeling, or loss of adhesion when bent (coated side in tension) 180 degrees over a conical mandrel in accordance with ASTM D 522, Test Method B. Panels shall be examined immediately after bending.

#### Adhesion

The thermoplastic powder coating shall exhibit a minimum of 1000 psi adhesion to the aluminum and steel substrates in accordance with ASTM D 4541.

#### Thermal Shock Resistance

The applied thermoplastic powder coating shall withstand 10 temperature cycles without cracking, checking, or disbonding. Cycles should be from +104 °F to -40 °F.

#### Impact Resistance

The applied thermoplastic powder coating shall resist minimum direct and reverse impacts of 36 inch-pounds without cracking, disbonding or holiday formation as determined by visual inspection. Test panels shall be impacted in accordance with ASTM D 2794 using a 2 pound weight with a 0.5" diameter indenter dropped from a height of 18".

#### Abrasion Resistance

Weight loss from the applied thermoplastic powder shall not exceed 90 milligrams. Test panels shall be tested for 1000 cycles using a Taber Abrader apparatus with CS-17 wheels and 1000 gram weights in accordance with ASTM D 4060. Weight loss shall be determined immediately after test to three significant figures.

#### Salt Spray Resistance

Unscribed: There shall be no blisters, wrinkles or loss of adhesion nor any general surface corrosion or pitting after 1000 hours of salt spray exposure.

Scribed: There shall be no blisters, wrinkles nor any general surface corrosion or pitting after 1000 hours of salt spray exposure. There shall be no more than 10mm loss of adhesion from a scribed line after 1000 hours of salt spray exposure.

#### Fluid Resistance Properties

The applied thermoplastic powder coatings shall exhibit no objectionable alteration to the surface such as discoloration, change in gloss, blistering, softening, loss of adhesion, formation of holidays or special phenomena after immersion for 7 Days in accordance with ASTM D 1308 in the following fluids.

1. Distilled water.
2. Type III hydrocarbon (per Federal Spec. TT-S-735).
3. Hydraulic fluid (per Mil-H-83282).

#### Chemical Resistance

The applied thermoplastic coating shall exhibit no objectionable alteration to the surface such as discoloration, change in gloss, blistering, softening, loss of adhesion, formation of holidays or special phenomena after immersion for 7 Days in accordance with ASTM D 1308 in the following chemical solutions:

1. 3M aqueous CaCl<sub>2</sub>.
2. 3M aqueous NaOH.
3. Saturated aqueous Ca(OH)<sub>2</sub>.
4. Aqueous solution of H<sub>2</sub>SO<sub>4</sub> (specific gravity = 1.29 ±0.02).

#### Dielectric Strength

The applied thermoplastic coating shall have a dielectric strength of 900 ±100 v/mil at 15 mil in accordance with ASTM D 149.

#### Weathering Properties

The applied thermoplastic coating shall exhibit the following resistance to weathering:

1. **Accelerated weathering.** The applied thermoplastic powder coating shall show no cracking, significant color change (fade), chalking, blistering, wrinkling or loss of adhesion, nor shall there be any evidence of substrate corrosion after 2000 hours exposure to accelerated weathering in accordance with ASTM G 53 using UVB-313 fluorescent lamps. The coating, shall exhibit no more than 30% loss in 60 degree specular gloss after exposure.
2. **Humidity resistance.** Test panels shall be exposed to a 120°F ±2°F, 100% relative humidity environment in accordance with ASTM D 2247 for 30 Days. The coating shall show no blistering, wrinkling or loss of adhesion nor shall there be any evidence of substrate corrosion after humidity exposure.
3. **Holidays.** The applied thermoplastic powder coating shall be free of holidays at an application thickness of 20-25 mil. holiday detection shall be performed with a low voltage (75-100 volts) direct current detector.
4. **Shelf life.** Powder coating Materials shall meet the requirements of the Owner, with a minimum of 2 years from the date of manufacture when stored below 85°F, 50% relative in the unopened original container.

#### **Material Safety Data Sheets (MSDS)**

Material Safety Data Sheets shall be provided to the Engineer.

#### **9-30.1(6)D POLYETHYLENE ENCASEMENT (FILM WRAP)**

Plastic film wrap for polyethylene encasement shall be 8 mil polyethylene conforming to AWWA C105.

See Section 9-30.1(6)B for multi-layered polyethylene encasement.

#### **9-30.1(6)E HEAT SHRINK JOINT SLEEVE**

The sleeve shall be Aqua Shield, or approved equal. The sleeve shall be a wrap around type with a joint closure and shall contain a thermal indicator.

#### **9-30.1(6)F WAX TAPE COATINGS**

Petrolatum-impregnated wax tape coating shall conform to AWWA C217. Acceptable products are 1) - #1 Wax-Tape as manufactured by The Trenton Corporation, Ann Arbor, MI, or 2) - Densyl Tape as distributed by Denso North America Inc., Houston, TX, or 3) - approved equal.

See Section 7-12.3(8) for field application construction requirements.

#### **9-30.2 FITTINGS**

##### **9-30.2(1) DUCTILE IRON PIPE**

Fittings for ductile iron pipe shall be ductile iron conforming to AWWA C110, and AWWA C111 or AWWA C153 and shall be cement-mortar lined conforming to AWWA C104.

Except where restrained joint systems are required, fitting joints shall be mechanical joint.

Where restrained joint pipe is required, threaded flanges by restrained joint adapters shall not be longer than three pipe diameters. Threaded flanges and pipe shall conform to AWWA C115. The exterior flange lip overlapping the pipe barrel shall be sealed with a bituminous mastic.

Sleeves less than 12 inches in diameter shall be 12 inches minimum length and shall be mechanical joint.

Sleeves greater than 12 inches in diameter shall be of the long body type and shall be 15 inches minimum length and shall be mechanical joint.

Where ductile iron pipe is to be joined to existing cast iron pipe of the same nominal size, and electrical isolation is not required at the connection, and the outside diameter of the existing cast iron pipe varies 0.05 inches or less from the specified outside diameter of the ductile iron pipe being joined, the pipe shall be joined with a mechanical joint sleeve.

Where 10 inch through 24 inch diameter ductile iron pipe is to be joined to existing cast iron pipe of the same nominal size, and electrical isolation is not required at the connection, and the outside diameter of the existing cast iron pipe conforms to AWWA 1908 classifications A, B, C, or D, the pipe shall be joined with a transition mechanical joint sleeve having a single-piece body.

Where 8 inch or smaller diameter ductile iron pipe is to be joined to existing cast iron pipe of the same nominal size, and electrical isolation is not required at the connection, and the outside diameter of the existing cast iron pipe conforms to AWWA 1908 classifications A, B, C, D, E, or F, the pipe shall be joined with a transition mechanical joint sleeve having a single-piece body.

Hub-by-flange fitting length shall conform to AWWA C110 or AWWA C153. The body of hub-by-flange fittings shall be a single-piece casting. Threaded pipe and flange combinations shall not be used.

##### **9-30.2(2) RESERVED**

##### **9-30.2(3) RESERVED**

##### **9-30.2(4) STEEL PIPE**

Fittings for steel pipe 3-1/2 inches in diameter and smaller shall be malleable iron threaded type with a pressure rating of 150 psi. Dimensions shall conform to ANSI B16.3. Threading shall conform to ANSI B2.1. Material shall conform to ASTM A 47, Grade 32510. All fittings shall be banded and hot-dip galvanized inside and out.

Unions shall be malleable iron with a pressure rating of at least 150 psi. Material shall conform to ASTM A 47, Grade 32510. Unions shall be ground joint, bronze to iron type.

Steel fittings for pipe 4 inches in diameter and larger shall be in accordance with AWWA C208. The class of the fittings shall be at least the same as that of the pipe. Coatings for couplings and fittings shall be factory applied. Field couplings shall be compression type. When flanges are required, they shall conform to AWWA C207. Buried couplings, bolts and followers shall be coated with wax tape per Section 7-11.3(8)A.

**9-30.2(5) RESERVED**

**9-30.2(6) RESTRAINED JOINTS**

Restrained joints, where required on the Drawings, shall be flexible after assembly and be able to be disassembled. Restrained joints shall meet the following criteria:

1. The restrained joint shall have a positive metal to metal contact locking system without the use of gripping teeth,
2. The joint restraint system for the pipe shall be the same as the joint restraint system for the pipe fittings, and
3. The joint restraint system for the pipe shall be boltless if the Drawings show joint bonding.

**9-30.2(7) TRANSITION REDUCING, AND INSULATING FLEXIBLE COUPLINGS**

Transition couplings, reducing couplings, transition reducing couplings, sleeves, and flexible insulating couplings for Water Main shall be compression type by pipe manufacturer: Romac or Ford or approved equal. Bolts and nuts shall be corrosion resistant per AWWA C111. Stainless steel bolts require anti-seize compound. The long body pattern with a minimum length of 10 inches for pipe up to 12 inches diameter and 15 inches minimum length for pipe greater than 12 inches diameter. Factory finish shall be fusion bonded epoxy or Plascoat PPA 571 thermoplastic coating.

**9-30.2(7)A INSULATING COUPLINGS**

Insulating couplings and flange kits shall be required at any point of connection of two dissimilar metallic Material pipes (i.e., ductile iron to cast iron) as shown on the Drawings. The insulating coupling body shall be coated with either thermoplastic powder coating Plascoat PPA 571 fusion-bonded epoxy conforming to AWWA C213, or high-build polyamide epoxy conforming to AWWA C210, and shall be a liquid coating, portable water grade, capable of 4 to 8 mil dry film thickness per coat, or thermoplastic powder coat per Section 9-30.1(6)C; insulating boot shall cover the pipe end to prevent metal contact between pipe sections being joined. The insulating boots and rubber gaskets shall be virgin synthetic butyl rubber compatible for potable water service. The nuts and bolts shall be stainless steel ASTM F 593, Type 316. The insulating coupling shall be manufactured by Romac Industries, Inc., or approved equal.

**9-30.2(7)B INSULATING FLANGE KITS**

Insulating flange kits shall consist of a full-face neoprene faced phenolic, type "E" O-ring gasket; insulating sleeves and washers manufactured from glass reinforced epoxy design; and 1/8 inch thick plated, hot rolled steel washers. Acceptable Suppliers are Pipeline Seal and Insulator (PSI) Inc., Houston, Tx.; Central Plastics Co., Shawnee, OK.; or approved equal.

**9-30.2(8) RESTRAINED FLEXIBLE COUPLINGS AND SLEEVES**

Restrained flexible couplings or sleeves shall be as indicated on the Drawings.

**9-30.2(9) SPECIAL FITTINGS**

Special fittings shall be as indicated on the Drawings.

**9-30.2(10) TWO-INCH BLOWOFF ASSEMBLY**

Two inch blowoff assembly shall be as indicated on Standard Plan nos. 340a and 340b at the locations shown on the Drawings.

Two inch service tube shall be Type K copper. Two inch gate valve shall be of iron-body construction, having bronze seat rings and stem, an o-ring stem seal system, shall be fitted with a 2 inch square operating nut, F.I.P.T. inlet and outlet threading conforming to ANSI B2.1, and shall be minimum 150 pounds working water pressure rated. Plastic foam Material shall conform to Section 9-30.2(11). Frame and cover shall conform to Section 9-30.3(12)H. Meter Box shall conform with Section 9-30.6(8).

**9-30.2(11) PLASTIC FOAM (ETHAFOAM)**

Plastic foam shall be in accordance with Section 9-05.10.

**9-30.2(12) CEMENT CONCRETE**

Cement Concrete for pipe support saddles and cradles and for thrust blocking shall be Class 3000 (see Section 6-02).

**9-30.2(13) RESERVED**

**9-30.2(14) STEEL CASING PIPE**

Steel casing pipe shall have a diameter and wall thickness as specified on the Drawings. Pipe shall be smooth and bare.



**9-30.2(15) SEALS AND SPACERS FOR STEEL CASING PIPE****9-30.2(15)A SEALS**

Casing end seals shall be used to completely seal the annular space between the casing and the Water Main at each end of the casing. Casing end seals shall provide a moisture-proof seal that is resistant to heat, cold, vibration, impact, abrasion, disbonding, expansion and contraction, and shall be impermeable. Acceptable seals are standard pull-on model S, or custom pull-on model C as manufactured by Pipeline Seal and Insulator, Inc., or approved equal.

**9-30.2(15)B SPACERS**

Casing spacers shall be bands at least 12 inch in width, and shall be either stainless steel or heavy duty fusion bonded epoxy coated steel. Runners shall be 2" wide glass reinforced plastic securely bonded to the spacer, and shall be aligned on the spacer along the axis of insertion of Water Main into casing pipe. Runner length shall approximate the width of the spacer. Securing the spacer to the Water Main shall be in accordance with the manufacturer's instruction.

Acceptable spacers are Pipeline Seal and Insulator, Inc. (PSI) model S12G-2 for stainless steel and model C12G-2 for coated steel, or approved equal.

**9-30.3 VALVES****9-30.3(1) GENERAL - MANUFACTURE AND MARKING**

The valves shall be a standard pattern of a manufacturer whose products are approved by the Engineer and shall have the name or mark of the manufacturer, year valve casting was made, size, and working pressure plainly cast in raised and legible letters on the valve body. All valves shall be NSF approved and valve bodies shall be ductile iron. All valves shall be stamped with both "NSF APPROVED" and "DI".

Where a valve is required to operate in a higher pressure environment than the Class of valve specified in Section 9-30.3, the class of valve shall be as specified in the Contract.

**9-30.3(2) GATE VALVES****9-30.3(2)A GATE VALVES - DOUBLE DISC**

In addition to 9-30.3(1), gate valves 3 inch through 12 inch shall conform to AWWA C500, be equipped with non-rising stems and "O" ring stuffing box, and with double disc gates having a bronze wedging device.

All gate valves shall have a ductile iron body.

Valves shall open counterclockwise when viewed from above, and shall be equipped with a standard AWWA 2 inch square operating nut. Valves shall be double disc-bronze seated valves if they have iron bodies.

Three (3) Manufacturer's Certificates of Compliance demonstrating performance tests comply with AWWA C500 shall be submitted to the Engineer.

Valve ends shall be mechanical joint. Where restrained joints are called out, valve ends shall be flanged with appropriate flange by restrained joint adapters per Section 9-30.2(1).

The valves shall be as manufactured by Clow, M & H, American Flow Control (ACIPCo), Pratt/Mueller, M&H/Kennedy, or approved equal in sizes 12 inches or less.

Gate valves 2-1/2 inch and smaller shall be of ductile iron body construction having bronze seat rings and stem, o-ring seal system, F.I.P.T. (female iron pipe thread) inlet and outlet conforming to ANSI B2.1, a standard AWWA 2 inch operating nut, and shall be minimum 150 pounds water working pressure.

The 2 inch and smaller valves shall be manufactured by Kennedy, Nibco-Scott, Stokum, or approved equal.

**9-30.3(2)B GATE VALVES RESILIENT SEAT**

Gate valves 3 inch through 12 inch shall conform to AWWA C509 and Section 9-30.3(1).

**9-30.3(3) RESERVED****9-30.3(4) BUTTERFLY VALVES**

In addition to the requirements of section 9-30.3(1), Water Main butterfly valves shall conform to AWWA C504 and shall be Class 150B. The valve shall be short-body type and shall have flanged ends. Flanged ends shall be sized and drilled in conformance with ANSI B16.1 Class 125. Valve shall be suitable for direct burial installation; however butterfly valves 12 inch and larger shall be installed within an access vault sized to permit removal and replacement of the valve.

All butterfly valve bodies and discs shall be ductile iron.

Butterfly valves other than AWWA C504 Class 150 and butterfly valves installed on water transmission pipeline shall be as indicated in the Contract.

Where butterfly valves are installed on restrained joint Water Mains, the valve ends shall be flanged with flanged by restrained joint adapters per Section 9-30.2(1).

Valves shall be mounted on the Water Main or pipeline such that the operating nut is accessible and operable from above.

Operator shall be manual, fully enclosed, and suitable for buried service. It shall open left (counterclockwise when viewed from above), and shall be equipped with a standard AWWA 2 inch square operating nut.

Operators for 16 inch and larger valves shall be equipped with external indicators, visible from above, which show the position of the valve disc.

Unless otherwise indicated in the Contract, the minimum number of turns from fully open to fully closed on Class 150 butterfly valves shall be as follows:

DIAMETER	TURNS, MIN.
4 inch to 8 inch	16 turns
10 inch to 12 inch	28 turns
14 inch to 18 inch	30 turns
20 inch	60 turns
24 inch	100 turns
30 inch	150 turns
36 inch and larger	200 turns

A Manufacturer's Certificate of Compliance stating that the valves to be furnished fully comply with AWWA C504 and the modifications contained herein shall be submitted to the Engineer before incorporation of the valve into the Work.

Unless the Contract specifies otherwise, bolting and torquing for the valve connection to the Water Main shall be as recommended by the manufacturer including any connection coating requirement when buried in soil. Wearing surfaces shall be bronze or other approved noncorrosive Material and there shall be no moving bearing or contact surface of iron in contact with iron. Rubber seat shall be retained in the body and shall mate against a stainless steel surface mounted on the disc. Contact surfaces shall be machined and finished in the best workmanlike manner, and all wearing surfaces shall be easily renewable.

The butterfly valves shall be manufactured by Henry Pratt Company, Mueller, DeZurick, Mosser Valve Division of Olsen Technologies, or approved equal.

The valve manufacturer shall provide a non-corrosive durable metal tag, measuring 4 inches by 6 inches, or other size as approved by the Engineer, with the number of turns to fully open/close the valve permanently stamped on the tag. A non-corrosive high strength durable cord, approximately 18 inches in length, shall permanently attach the tag to either the bottom end of the valve box or the lower section of the valve chamber frame, as applicable.

#### **9-30.3(5) VALVE BOXES**

Valve boxes shall be installed on all buried valves. The box and lid shall be cast iron, 2-piece slip type with cast iron extension as necessary, conforming to requirements and dimensions of the current Seattle Public Utilities - Water Utility Standards.

The cover shall have the word "WATER" or the letter "W" cast in it.

Valve boxes, lids and extensions of the following manufacture and pattern are approved for use:

045 Valve Box (Olympic Foundry Inc.) Standard Base and Extension

Lid Section # 13-5010

Top Section # 13-5020

Base Section # 13-5021

24" Valve Box Complete Assembly - 00366420A01

30" Valve Box Complete Assembly - 00366420A02

36" Valve Box Complete Assembly - 00366420A03.

Lid Section – 00366420

Top section – 00366412

Base Sections:

24 inch – 85556024

30 inch – 85556030

36 inch – 85556036

Each top and lid section shall be tested for accuracy of fit and shall be marked in sets for delivery.

Valve box extension pieces shall be provided for valves with ground cover in excess of the depth of the standard valve box (see Standard Plan nos. 315a and 315b).

#### **9-30.3(6) RESERVED**

#### **9-30.3(7) COMBINATION AIR RELEASE / AIR VACUUM VALVES**

Combination air release/air vacuum valves shall comply with the requirements of ANSI / AWWA C512.

#### **9-30.3(8) END CONNECTIONS**

The dimensions of hub or bell end connections shall conform to the dimensions of AWWA C100. The dimensions for the mechanical joint connections shall conform to the ANSI A21.11.

The end flanges of flanged valves shall conform in dimensions and drilling to the standard ANSI B16.1 for cast iron flanges and flanged fittings, Class 125, unless specifically provided otherwise in the Contract. The bolt holes shall straddle the vertical center line.

**9-30.3(9) RESERVED****9-30.3(10) OPERATING NUT EXTENSIONS**

An operating nut extension conforming to Standard Plan no. 315b shall be furnished and installed by the Contractor on all valves where the finished grade is more than 30 inches above the valve operating nut.

**9-30.3(11) PLASTIC FOAM RINGS**

Valve boxes shall have a 2 inch thick plastic foam cushion installed between the base flange of the valve box bottom section ring conforming to the dimensions shown on Standard Plan no. 315b installed between the base and the valve casting. The plastic foam shall conform to the requirements of Section 9-05.10.

**9-30.3(12) VALVE CHAMBERS****9-30.3(12)A PRECAST VALVE CHAMBER**

Size, shape, and Materials shall be as indicated on the Drawings.

The chambers shall be furnished in precast concrete sections with sufficient strength to withstand HS 20 traffic loading together or as specified on the Drawings with ladder and access frames and covers to provide the minimum clearance dimensions shown on the Drawings.

The chambers shall be watertight after assembly. Gasket Material shall be installed in the groove of the keyway of each chamber section as it is installed. There shall be no evidence of moisture seeping into the chambers through the walls, floor, or joints.

**9-30.3(12)B CONCRETE BLOCKS FOR VALVE CHAMBERS**

Portland cement concrete blocks shall be solid, and shall conform to the requirements of ASTM C 139. Overall thickness of block shall be 6 inches with optional lengths and widths. Curved maintenance hole blocks shall be used for round valve chambers.

**9-30.3(12)C CONCRETE BRICK FOR VALVE CHAMBERS**

Concrete brick shall be solid and conform to ASTM C 55, Grade A.

**9-30.3(12)D CLAY BRICK FOR VALVE CHAMBERS**

Clay brick shall conform to ASTM C 62, Grade SW.

**9-30.3(12)E MORTAR**

Portland cement mortar shall be 1 part Portland cement to not less than 1-1/2 parts nor more than 3 parts of plaster sand, mixed with the least amount of water necessary to provide a workable mix. Dehydrated lime, in an amount not exceeding 50 percent of the Portland cement by weight, may be added to the mix at the option of the Contractor.

**9-30.3(12)F CEMENT CONCRETE**

Cement Concrete for chamber foundation shall be Class 3000 (see Section 6-02).

**9-30.3(12)G CAST-IN-PLACE CONCRETE VALVE CHAMBER**

The design, size, shape, and Materials for cast-in-place concrete valve chambers shall be in accordance with the Drawings. The Contractor shall submit Shop Drawings of the chamber indicating all features to the Engineer per Section 1-05.3.

**9-30.3(12)H FRAME AND COVER AND VALVE BOX CASTINGS**

Castings for cast iron frame and cover and for cast iron parts of valve boxes shall conform to the requirements of ASTM A 48, Class 30 and shall conform to the Standard Plans unless specified otherwise in the Contract.

The word "WATER" shall be cast in the cover in 3 inch letters as indicated on the Standard Plans.

Each ring and cover section shall be tested for accuracy of fit and shall be marked in sets for delivery.

An acceptable Supplier is Olympic Foundry Type SM29 standard box and lid, EJ Type EJ3761 Series or other approved equal.

See Section 9-30.3(4) regarding the permanent connection of the tag, indicating the number of turns to fully open/close the butterfly valve, to the valve box or to the valve chamber.

**9-30.3(12)I MORTAR FOR PLASTER-COATING**

Mortar for plaster-coating masonry unit maintenance holes shall be proportioned according to either of the two following tabulated alternates:

	<b>PARTS BY VOLUME PORTLAND CEMENT</b>	<b>PARTS BY VOLUME MASONRY CEMENT</b>	<b>PARTS BY VOLUME HYDRATED LIME OR LIME PUTTY</b>
alternate 1	1	1 (Type II)	0
alternate 2	1	0	1/4

Plaster sand for either alternate 1 or alternate 2 above shall be measured in a damp, loose condition, and shall be not less than 2-1/4 and not more than 3 times the sum of volumes of cement and lime.

A bituminous coating shall be applied to all surfaces after plastering.

#### **9-30.3(12)J LADDERS**

Ladder shall be made of steel, and shall be galvanized after fabrication. They shall be made of 1 inch deformed steel bar conforming to ASTM A 615, intermediate or standard grade, hot bent at least 1600°F. Galvanization shall conform to ASTM A 123.

#### **9-30.3(13) PAINTING AT FACTORY**

After the factory test and inspection, all ferrous parts of the valves except finished or bearing surfaces shall be painted inside and out with two coats of asphalt varnish, Federal Specification TT-V-51A or approved equal.

#### **9-30.3(14) WATER PRESSURE REGULATING VALVES**

##### **1. Water Pressure Regulating Valves, 3 inch through 12 inch Sizes:**

Valve shall be flanged at both ends, Class 150 ASA drilling, with ductile iron body. Valve shall be a diaphragm operated, single seat, globe valve with stainless steel trim. It shall be spring loaded and hydraulically operated. Seat ring shall be replaceable. The diaphragm shall be fully guided top and bottom. All necessary repairs shall be possible without removing the valve from the line. Packing glands are not permitted. Disc shall be synthetic rubber and have a rectangular cross section. The stem shall be guided by a bearing in the valve cover and an integral bearing in the valve seat. There shall be no piston operating the main valve.

Valves shall be designed to maintain a constant downstream pressure regardless of varying inlet pressure. They are to be used in handling clean, cold water.

No control pilots or optional equipment is to be furnished. Valves shall be CLA Valve No. 90 or approved equal.

##### **2. Water Pressure Regulating Valves, 2 inch Size:**

Valves shall be Mueller No. H-9310 2 inch Water Pressure Reducing Valves or approved equal.

#### **9-30.3(15) COATINGS FOR VALVES**

Special coatings, thermoplastic powder coating, and polyethylene encasement shall be per Section 9-30.1(6).

#### **9-30.4 RESERVED**

#### **9-30.5 HYDRANTS**

##### **9-30.5(1) GENERAL**

Fire hydrants shall conform to AWWA C502 and shall be of standard manufacture and of a pattern approved by SPU Water Operations. The name or mark of the manufacturer, size of the valve opening and year made shall be plainly cast in raised letters on the hydrant barrel to be visible after the hydrant is installed.

Hydrants of the following manufacture and pattern have been approved for use by the City of Seattle:

1. Pacific States
2. Clow Model 5110 (Iowa)
3. Mueller "Centurion" Model A-423
4. American-Darling Model B-62B
5. Kennedy K81D "Guardian"

##### **9-30.5(2) END CONNECTIONS**

The end connection shall be 6 inches, standard flange, Class 125 drilling conforming to ANSI B16.1.

##### **9-30.5(3) HYDRANT DIMENSIONS**

The dimensions and details of hydrant and nozzles shall be as follows:

1. Hydrant connection pipe size inside diameter: 6 inches.
2. Standpipe, minimum inside diameter: 7 inches.
3. Valve opening, minimum diameter: 5-1/4 inches.
4. Size of auxiliary gate valve: 6 inches.
5. Hose nozzles, number and size: two 2-1/2 inches.
6. Thread (National Board of Fire Underwriters): 7-1/2 per inch.
7. Total length of threaded male nipple: 1 inch.
8. Streamer nozzle, number and size: one 4 inch.
9. Hydrants shall be furnished with one pumper nozzle with size and threads conforming to dimensions as identified on the current City of Seattle Standard Plans for Fire Hydrants.
10. Drain Valve: Drain valve shall be automatic with outlet tapped with 1/4 to 3/4 inch female iron pipe threads. The threads on the drain valve outlet holes shall be protected with temporary pipe plugs until the hydrant is ready for installation.
11. Breakaway flange (ring) to center of pumper nozzle: 14 inches or more.
12. Face: Pumper port toward the street.

All nozzles shall be fitted with cast iron threaded caps with operating nut of the same design and proportions as the hydrant stem nut. Caps shall be threaded to fit the corresponding nozzles and shall be fitted with suitable neoprene gaskets for positive water tightness under test pressures.

#### **9-30.5(4) OPERATING NUTS**

The operating nuts on hydrant stem and nozzle caps shall be as follows:

Pattern of nut	Tapered pentagonal
Height	1-1/6 inch
Size of pentagon	1.35 inch at bottom of nut
	1.23 inch at top of nut (measured from point to flat)

The direction of opening shall be clearly marked on the operating nut or hydrant and shall be counter clockwise

#### **9-30.5(5) HYDRANT RESTRAINT**

##### **9-30.5(5)A RESTRAINT SYSTEM FOR SHACKLE RODS**

Shackling rods shall be 3/4 inch diameter with threaded ends, and shall meet ASTM A 36. "All-thread" rod is not acceptable. If a tie bolt restraint system is used, it shall be "COR-TEN Steel Star National Products Super Star Tie Bolt #SST7" or approved equal. If a mechanical joint- gland-with-lugs restraint system is used, it shall conform dimensionally as shown on the hydrant detail, and shall be ductile iron conforming to ASTM A 536 Class 80-55-06. Coating for shackling rods shall be in accordance with Section 9-30.15.

##### **9-30.5(5)B RESTRAINT SYSTEM FOR WEDGE RESTRAINT GLANDS**

If a wedge restraint system is used in lieu of shackle rods, mechanical joint (MJ) pipe shall be used rather than slip joint (SJ) pipe. The wedge restraint system shall conform to AWWA C111, ASTM A 536-80 Grade 65-45-12. All bolts and wedges shall be ductile iron. Wedges shall be heat-treated to a minimum 370 BHN. The wedge restraint system shall be rated for 350 psi for pipe 12 inch in diameter and smaller. Wedge restraint systems shall be tape wrapped and joint bonded if installed on coated Water Main.

#### **9-30.5(6) BREAKAWAY FLANGE CONSTRUCTION**

Hydrants shall be provided with a breakaway flange assembly and be equipped with breaking devices at the sidewalk flange which allow the hydrant barrel to separate at this point with a minimum breakage of hydrant parts in case of damage. There shall also be provided at this point, a safety stem coupling on the operating stem that shears at the time of impact. Unless otherwise specified in the Contract, all hydrants shall be equipped with O-ring stem seals.

#### **9-30.5(7) HYDRANT PAINTING**

##### **9-30.5(7)A HYDRANT SHOP PAINTING**

All iron parts of the hydrant shall be thoroughly cleaned and painted at the factory. All inside surfaces and the outside surfaces below the ground line shall be coated with asphalt varnish, Federal Specification TT-V-51a or J.A.N.P-450, unless otherwise specified in the Contract. They shall be covered with two coats, the first having dried thoroughly before the second is applied.

##### **9-30.5(7)B HYDRANT FIELD TOUCH-UP PAINTING**

All iron parts of the hydrant shall be thoroughly cleaned and painted at the factory. All inside surfaces and the outside surfaces below the breakaway flanges shall be coated with asphalt varnish, Federal Specification TT-V-51a or J.A.N.P-450, unless otherwise specified in the Contract. They shall be covered with two coats, the first having dried thoroughly before the second is applied.

The hydrant curb stand section, including all exposed surfaces of the breakaway flange, shall receive two coats of oil based gloss enamel paint (Kelly-Moore Luxlite or approve equal) in Caterpillar yellow. Based on the elevation of the hydrant within the surrounding pressure zone, if the maximum static pressure at the hydrant is less than 60 psi, the engine port cap on the hydrant shall be painted with two coats of oil based gloss enamel paint (Kelly-Moore Luxlite or approve equal) with the final coat being Red.

#### **9-30.5(8) HYDRANT FACTORY HYDROSTATIC TEST**

All hydrants shall be tested by the manufacturer, as required in AWWA C502. The Contractors shall furnish to the Owner an affidavit of compliance from the manufacturer for all tests.

#### **9-30.5(9) HYDRANT CONNECTION PIPE**

Pipe connections from the hydrant to the Water Main shall be 6 inch Ductile Iron Pipe, Class 52, in accordance with Section 9-30.1(1).

#### **9-30.5(10) HYDRANT VERTICAL EXTENSIONS**

Hydrant barrel extensions shall have a 7 inch minimum inside diameter and shall be gray cast iron or Ductile Iron and shall conform to the AWWA Standards for such castings. The drillings of the connecting flanges on the extensions shall match the drillings of the flanges on the hydrant.

Hydrant vertical extensions shall also include the necessary hydrant operating stem extension, complete with safety stem couplings.

Extensions with threaded flanges shall be ductile iron and shall conform to AWWA C115. The exterior flange lip overlapping the barrel pipe shall be sealed with a bituminous mastic.

Vertical extensions shorter than 18 inches shall be installed at the bottom of the factory supplied barrel pipe.

#### **9-30.5(11) HYDRANT BLEEDER**

The hydrant bleeder assembly, as shown on the hydrant detail, shall be constructed of 3/4 inch copper tubing Type K, conforming to Section 9-30.6(4).

#### **9-30.5(12) POLYETHYLENE ENCASEMENT AND SPECIAL TAPE COATING FOR HYDRANTS AND CONNECTIONS**

Refer to Section 9-30.1(6).

### **9-30.6 SERVICE CONNECTIONS AND SERVICE PIPE OR TUBING**

#### **9-30.6(1) GENERAL**

Service piping standards shall be used, and modified when indicated on the Drawings, for 2 inch blowoff assembly and hydrant bleeder assembly.

#### **9-30.6(2) SADDLES**

Saddles shall be ductile iron, or bronze, double straps with thread standard outlet tapping. Saddles shall be of a size designed by the manufacturer to fit the pipe called for on the Drawings.

#### **9-30.6(3) CORPORATION STOPS**

Corporation stops for use with saddle shall be of bronze alloy with inlet M.I.P. (male iron pipe) standard thread and outlet thread compatible with connection piping, with no special adapters. Corporation stops for direct tapping shall be bronze alloy with AWWA tapered inlet. Outlets shall be on 3/4 inch and 1 inch direct tap corporation stops shall be copper tubing size compression, with an external clamping or anti-pullout feature. Outlets on 1-1/2 inch and 2 inch direct tap corporation stops shall be male iron pipe or tubing to be connected.

#### **9-30.6(4) SERVICE PIPE**

##### **9-30.6(4)A COPPER TUBING**

Copper tubing shall conform to the requirements of ASTM B 88, Type K, annealed. The tubing shall be coupled using compression fittings having a positive external gripping feature to prevent tubing pull-out, conforming to the requirements of AWWA C800, minimum 150 psi working pressure.

#### **9-30.6(5) COMPRESSION COUPLINGS**

Compression couplings for use in connecting plain end water service pipes shall be applicable for the type of pipe being coupled. Compression couplings shall have armored gaskets when similar metal pipes are being joined.

#### **9-30.6(6) RESERVED**

#### **9-30.6(7) METER STOPS AND SETTERS**

Meter stops and setters shall be in accordance with the SPU Water Operation Standards.

#### **9-30.6(8) METER BOX AND LID**

Meter Box and Lid shall be in accordance with the current SPU Water Operation Standards. The Meter Box casting shall conform to ASTM A 48, Class 30 for gray cast iron. The Lid casting shall conform to ASTM A 536, Grade 80-55-06 for ductile iron. Castings shall be brushed or dipped with a bituminous coating. Meter Box and Lid shall be Olympic Foundry (1984) Inc. SM-29, or approved equal.

#### **9-30.6(9) VALVES**

Valves shall conform to Section 9-30.3.

### **9-30.7 BEDDING, FOUNDATION MATERIAL AND GRAVEL**

When the Mineral Aggregate is specified by a "Type" designation, it shall conform to the requirements in Section 9-03. See Section 7-10.3(9) for bedding requirements.

#### **9-30.8 RESERVED**

#### **9-30.9 RESERVED**

#### **9-30.10 JOINT BOND CABLE**

General joint bond cable shall be single-conductor No. 2 AWG stranded copper wire with 600-volt, 7/64" thick high molecular weight polyethylene (HMWPE) insulation. Supply all joint bonds complete with a formed copper sleeve on each end of the wire, as specified under THERMITE WELD MATERIALS, this Section.

**9-30.11 THERMITE WELD MATERIALS****9-30.11(1) GENERAL**

Thermite weld Materials shall consist of wire adapter sleeves, welders, and weld cartridges according to the weld manufacturer's recommendations for each wire size and pipe or fitting size and Material. All welding Materials and equipment shall be the product of a single manufacturer. Interchanging Materials of different manufacturers will not be acceptable.

Molds shall be made of graphite. Ceramic "one-shot" molds will not be acceptable.

Steel thermite weld cartridges shall be used for steel pipe and fittings. Cast iron thermite weld cartridges shall be used for all cast and ductile iron pipe and fittings. Maximum cartridge sizes for steel thermite welds shall be: 15 grams for wire sizes #14 AWG through #4 AWG stranded, and 32 grams for #2 AWG stranded.

Maximum sizes for cast iron thermite welds shall be: 25 grams for #14 AWG through #6 AWG stranded, and 45 grams for #4 AWG solid through #2 AWG stranded.

Thermite weld Material may be obtained from the following Suppliers: Erico Products Inc. (Cadweld), Cleveland, Ohio; or Continental Industries, Inc. (Thermoweld), Tulsa, Oklahoma; or approved equal.

**9-30.11(2) ADAPTER SLEEVES**

Provide Adapter Sleeves for all No. 12 AWG through No. 2 AWG test station and joint bond wire. Prefabricated factory sleeve joint bonds or bond wires with formed sleeves made in the field are acceptable. Field-formed joint bond sleeves shall be attached with the appropriate size and type of hammer die provided by the thermite weld manufacturer.

**9-30.11(3) THERMITE WELD CAPS AND PRIMER**

Thermite Weld caps shall be prefabricated weld caps with coating and suitable primer, such as Handy Cap II with Royston Primer 707, as manufactured by Royston Laboratories, Inc., or equal.

**9-30.11(4) COATING REPAIR AT THERMITE WELD**

Repair of coating of pipe and fittings for spot damage at thermite weld connections not included in standard pipeline coating repair procedure, shall be 100% solid epoxy that cures in submerged or buried conditions. Repair of thermoplastic powder coating shall be as specified in Section 9-30.1(6)C6.

**9-30.12 ELECTROLYSIS TEST STATION****9-30.12(1) GENERAL - NON-TRAFFIC AREA**

An electrolysis test station shall consist of a standard meter box and lid as specified in Section 9-30.6(8) providing a housing for a test box as specified in Section 9-30.12(2).

**9-30.12(2) TEST BOX**

Test box requirements shall be as follows:

The 4" (10 cm) deep test box shall provide a single piece enclosure 8" by 6" (20 cm by 15 cm) with a removable, hinged lid. The test box shall be Hoffman No. 864CHQRFQ or approved equal.

The lid shall be manufactured from molded fiberglass reinforced Material, and fitted with a one-piece oil resistant "O" ring gasket. The lid shall be attached to the test box with a monel hinge pin and secured by quick release latches.

The test box shall comply with NEMA 4X standards, to supply protection against corrosion, windblown dust, rain, splashing water, and hose direct water.

A watertight connector consisting of a heat-shrinkable cable entry system, shall be used for passage of test wires into the enclosure. The entry system shall be a three part assembly consisting of a rigid plastic nut, a rubber O-ring, and molded heat-shrinkable cable entry seal including tape sealant. The cable entry system shall be type CES-2 or CES-3, with SFTS-1 or SFES-3 tape sealant as manufactured by Sigmaform Corporation; or approved equal.

**9-30.12(3) TEST STATION WIRES**

Test station wires shall be single conductor, No. 10 AWG and No. 6 AWG stranded copper with 600 volt XHHW insulation. Color of insulation per Drawings.

**9-30.12(4) WIRE CONNECTORS INSIDE TEST BOX**

Wire connectors inside the test box shall be one-piece, tin-plated crimp-on lug connector as manufactured by Burndy Co., Thomas and Betts, or equal.

**9-30.12(5) ZINC REFERENCE ELECTRODES**

The electrode shall be a 5 pound 99.9% pure zinc ingot packaged in a thoroughly mixed backfill material consisting of 75% gypsum, 20% bentonite clay and 5% sodium sulfate or a 50% gypsum and 50 % bentonite mix. The package shall be water permeable and of sufficient size to ensure complete envelopment of the reference electrode and shall include 50 feet of 12 gauge yellow RHW lead wire.

**9-30.12(6) ELECTRICAL CONDUIT AND FITTINGS**

PVC electrical conduit and fittings shall be schedule 40 and UL listed for direct burial. Conduit and fittings shall meet the requirements of NEMA TC and TC3, federal specification W-C-1094, UL and NEC.

**9-30.13 TURBINE METERS (METER, COLD WATER, MAGNETIC DRIVE TURBINE TYPE, SIZES 2" - 12")****9-30.13(1) GENERAL**

These requirements apply to Magnetic Drive Turbine Type Cold Water Meters 2 inch through 12 inch in size, manufactured for use on customer water services. Turbine Meters shall consist of a cast bronze case containing the measuring mechanism with a strainer housing attached.

Meters shall meet the requirements of AWWA C701, current edition, Class II type, except as modified herein.

**9-30.13(2) REGISTER AND REGISTER BOX**

Registration shall be in cubic feet.

**9-30.13(3) RESERVED****9-30.13(4) MEASURING MECHANISM**

The measuring mechanism shall be the inline type, and so designed that it can be readily removed from the main case as a complete unit. The measuring mechanism shall be capable of operating within the accuracy limits specified under "Normal Flow Limits" in Section 9-30.13(7) without recalibration when transferred from one turbine meter case to another.

**9-30.13(5) INTERMEDIATE GEAR TRAIN**

If an intermediate gear train is utilized, it shall operate in a dry, hermetically sealed compartment, separated from the water passage by a bronze wall.

**9-30.13(6) CAPACITY AND ACCURACY**

The turbine meter shall register all rates of flow through it with an accuracy of 100%  $\pm$  2% at rates of flow within the limits specified under "Normal Flow Limits" in Section 9-30.13(7).

**9-30.13(7) NORMAL FLOW LIMITS**

SIZE	NORMAL FLOW LIMIT
2-Inch	5 - 160 GPM
3-Inch	10 - 350 GPM
4-Inch	15 - 800 GPM
6-Inch	30 - 1800 GPM
8-Inch	50 - 3500 GPM
10-Inch	55 - 5500 GPM
12-Inch	70 - 7000 GPM

NOTE: Above flow limit shall be for continuous flows, all turbine meters shall have a 25% overspeed capacity for intermittent flows.

**9-30.13(8) HEAD LOSS**

Maximum loss of head shall not exceed 7 psi at the flow rates listed under "Normal Flow Limits" in Section 9-30.13(7).

**9-30.13(9) CONNECTIONS**

All main case connections shall be flanged. The flanges for 2 inch meters shall be of the two bolt oval type. Meters shall be furnished without companion flanges.

**9-30.13(10) INTERCHANGEABLE PARTS**

All parts of turbine meters of the same size, make and model shall be interchangeable.

**9-30.13(11) STRAINER**

Turbine meters shall be supplied with a strainer attached. Strainers shall be short pattern, 125 lb. ANSI, iron body, with heavy gauge 1/4 inch perforated, stainless steel screen having an effective straining area at least double that of the meter main case inlet.

**9-30.13(12) REMOTE READING**

Turbine meters shall be compatible with existing SPU Automated Meter Reading and Demand Recording Hardware and/or switches. Manufacturer, type, and style of switch shall be submitted for approval by the Engineer before ordering.

**9-30.13(13) MANUFACTURE AND APPROVAL**

Only meters manufactured by a well established firm will be considered. Only those meters of a specific model and manufacturer, samples of which have been submitted to SPU Water Meter Shop for inspection and approval, and carrying a minimum 1 year guarantee will be acceptable.

**9-30.13(14) INSPECTION**

All turbine meters purchased under this Specification will be subject to inspection and testing by SPU Water Meter Shop upon receipt, and if any meter is found not to conform with these Specifications, the lot or any portion thereof may be rejected.



**9-30.13(15) GUARANTEE**

All turbine meters shall be guaranteed for a period of 1 year after installation. This guarantee shall be against defects in Materials, workmanship, and construction.

**9-30.13(16) TEST REPORT**

All turbine meters purchased under this Specification shall be accompanied by a notarized test report of the factory accuracy test.

**9-30.14 LOCATING WIRE**

Locating wire shall be 14 gauge solid copper with neoprene coating. Connections and splices shall be made with Penn Wilson split Bolt Wire Connectors, catalog No. 5-8-5, or approved equal.

**9-30.15 COATING FOR ALL BOLTS AND SHACKLE RODS**

On corrosion protected Water Mains, all shackle rods, concrete blocking anchor rods, and shackle clamps shall have a factory applied protective coating with fusion bonded epoxy in accordance with ASTM A 755. After threading and assembly, the threaded ends, nuts, and washers shall be coated with a wrapping of Trenton wax tape #1 or approved equal.

**9-30.16 BACKFLOW PREVENTION ASSEMBLIES (BPAs)****9-30.16(1) GENERAL**

All backflow prevention assemblies (formerly called backflow prevention devices or BPDs) shall be on the Washington State Department of Health current list of approved backflow prevention assemblies, and both temporary and permanent installations of such assemblies shall be verified acceptable by the Engineer. The list of Washington State Approved assemblies is available at 1-503-246-5845.

All backflow prevention assemblies, whether temporary or permanent, are subject to inspection by SPU Inspection Services before connection with any Water Main. See Section 1-07.28 item 7D regarding BPA inspection notification requirements. After initial inspection and acceptance, annual testing is required.

Backflow prevention assemblies installed on premises, or not installed for premise isolation purposes, shall be inspected by Seattle King County Health Department Plumbing Inspection.

**9-30.16(2) ATMOSPHERIC VACUUM BREAKERS (AVBs)**

Atmospheric vacuum breakers shall be of a type included in the Washington State Department of Health current listing of "Acceptable Atmospheric (Non-Pressure) Type Vacuum Breaker" or other types with IAPMO approval. AVBs shall be installed downstream of the last shutoff valve and a minimum of 6 inches above the highest outlet or overflow level of the irrigation system. AVBs shall be installed above ground.

An atmospheric vacuum breaker shall be attached to each hose bib. An AVB shall not be operated for more than 12 hours in any 24 hour period. AVBs shall not be used on systems with chemical additions.

**9-30.16(3) PRESSURE VACUUM BREAKER ASSEMBLIES (PVBAs)**

Pressure vacuum breakers shall be of a type included in the Washington State Department of Health current listing of "Acceptable Pressure Type Vacuum Breaker" or other types with IAPMO or University of Southern California approval. PVBAs shall be installed a minimum of 12 inches above the highest outlet or overflow level of the irrigation system and located so that adequate room is available for maintenance and testing. PVBAs shall be inspected and tested annually during the life of the Contract by backflow device testers certified by the Washington State Department of Health. PVBAs shall not be installed below ground. PVBAs shall not be used for systems with chemical additions.

**9-30.16(4) DOUBLE CHECK VALVE ASSEMBLIES (DCVAs)**

Double check valve assemblies shall be of a type included in the Washington State Department of Health current listing of "Approved Double Check Valve Assemblies".

Installations shall be according to procedures outlined in the current edition of "Accepted Procedure and Practice in Cross-Connection Control Manual" published by the Pacific Northwest Section, American Water Works Association. DCVAs shall be inspected and tested annually during the life of the Contract by backflow device testers certified by the Washington State Department of Health.

DCVAs can be installed below ground only if enclosed in an approved irrigation vault, chamber, or other approved enclosure. DCVAs shall not be used for systems with chemical additions.

**9-30.16(5) REDUCED PRESSURE PRINCIPLE BACKFLOW PREVENTION ASSEMBLIES (RPBAs)**

Reduced pressure principle backflow prevention assemblies will be required for any system using chemical additions or proposed to use chemical additions. Such systems include irrigation systems with fertilizer or other chemical addition. These units shall be of a type included in the Washington State Department of Health current listing of "Approved Reduced Pressure Backflow Assemblies". Inspection of the installation, to insure proper operation, will be conducted by SPU Inspection Services. RPBAs shall be inspected and tested annually during the life of the Contract by backflow device testers certified by the Washington State Department of Health.

Installation shall be according to procedures outlined in the current edition of "Accepted Procedure and Practice in Cross-Connection Control Manual" published by the Pacific Northwest Section, American Water Works Association.

RPBAs shall not be installed below ground.

**9-30.16(6) RESERVED****SECTION 9-31 ILLUMINATION AND ELECTRICAL MATERIALS****9-31.1 LUMINAIRES****9-31.1(1) GENERAL**

Luminaires shall have attached to the housing, an ANSI approval decal (3 inches square) which shall be readily visible from the ground, indicating lamp type by color code (i.e., white for Light-Emitting Diode (LED), blue for Mercury Vapor, gold for High Pressure Sodium, red for Metal Halide); and lamp wattage by numerical code, i.e.:

Legends shall be a minimum of 2 inches in height and weather resistant.

External labels for (LED) luminaires shall conform to ANSI C136.15.

The Contractor shall be prepared to provide a sample luminaire for testing when requested by the Engineer.

**9-31.1(2) ROADWAY LIGHTING LUMINAIRE**

LED luminaires shall meet the requirements of the following SCL Material Standards:

For residential LED luminaires refer to SCL Material Standard 5723.47.

For collector-arterial LED luminaires refer to SCL Material Standard 5723.61.

For principal-arterial LED luminaires refer to SCL Material Standard 5723.71.

HPS luminaires shall meet the requirements of SCL Material Standard 5723.10.

Glare control shall be accomplished by use of a field-installable, house-side shield. For house-side shields, refer to above SCL Material Standards.

**9-31.1(3) LAMPS**

High pressure sodium lamps shall meet the requirements of SCL Material Standard 5722.45.

**9-31.1(4) PHOTOELECTRIC CONTROLS**

Photoelectric controls shall be used with all luminaires and shall meet the requirements of SCL Material Standard 5693.00 for standard applications, and SCL Material Standard 5693.10 for 20-year design life applications.

**9-31.1(5) RESERVED****9-31.1(6) UNDERDECK MOUNTED UNDERCROSSING LUMINAIRE**

For underdeck mounted undercrossing luminaires, refer to SCL Stock Catalog stock class 57.

Underdeck luminaires shall be pendant-mounted as called for on the Drawings. The ballast shall be integral with the luminaire. Ballast housing and structural parts shall be of cast aluminum. Mounting devices shall provide positive, vibration-proof locking. Luminaires shall be UL listed as "Enclosed and Gasketed" and shall be suitable for wet locations. All exposed screws and/or rivets shall be of stainless-steel Material.

All exposed cast aluminum parts are to be furnished with a baked-enamel paint.

The ballast housing and optical assembly shall be provided with easy-to-read moisture-proof nameplates that can be read without disturbing the luminaire when installed.

Ballast and optical assemblies shall include provision for field mounting of safety chains.

Luminaires shall have a wiring compartment with a single fuse holder.

Mounting of the optical assembly to the ballast assembly or pendant cap shall be secured by positive vibration-proof means. The optical and ballast or pendant cap assemblies shall include a positive aligning electrical disconnect allowing the socket to be shipped factory assembled in the optical assembly.

The luminaire shall be enclosed and gasketed and shall include an activated charcoal filter to permit passage of air.

Heat-resistant polycarbonate plastic shall be used for the refractor. The optical assembly shall be hinged and latched for lamp access. An automatic disconnect shall ensure that optical assembly is electrically cold when servicing. The optical assembly shall be removable from the ballast without tools.

The filter assembly shall be factory installed, but easily removable and shall be located to prevent accidental dislodgement when the luminaire is installed.

The unit shall provide at least 3% uplight dispersed widely across the surrounding area.

Luminaire shall be suitable for continuous service in an ambient temperature of 408C. The unit shall be weatherproof and dustproof.

Ballasts shall be multi-tap, high power factor, regulator type.

**9-31.1(7) WALL-PACK LUMINAIRE**

For wall-pack luminaires, refer to SCL Stock Catalog stock class 57.

The luminaire shall consist of a rear die-cast back housing which encloses the ballast, lamp socket and reflector, and a refractor frame assembly. The back casting assembly shall mount against the wall (or pole) and the refractor housing

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assembly shall fasten to it by means of concealed hinges and a single point, positive acting latch. There shall be plated steel retaining chain attached between the main housing and refractor frame. Overall dimensions shall be approximately 16 inches square by 10-3/8 inches deep.

Units shall be prewired and equipped to be wall mounted directly on conduit for surface wiring without bending the conduit or to a recessed outlet box, and shall require no tools for lamp replacement.

The optical train shall consist of the lamp, fluted specular aluminum reflector, and molded prismatic borosilicate thermal shock-resistant glass refractor. The dimensions of the refractor shall be approximately 16 inches square by 4 inches deep and shall have internal splitting prisms and external dispersing prisms. The refractor frame color shall be anodized aluminum.

The integral ballast shall operate the high-pressure sodium 55-volt lamp at the wattage shown on the Drawings, and provide reliable starting at temperatures as low as -20 °F. The ballast shall be multi-tap to allow field adjustments of voltage.

All insulation shall be UL listed Class H; core, coil, and capacitors shall be positioned for maximum heat dissipation. Supply wires to the unit are to be of proper temperature rating for the type of entry used. The housing shall be finished with a black polyester powder paint coating. The complete unit shall be UL listed as "Suitable for Wet Locations". The unit shall be Moldcast catalog no. PCL-1 or approved equal, to be furnished with photocontrol, wireway conduit adapter, and polycarbonate shield.

The wall-pack luminaire shall be furnished with photocontrol, wireway conduit adapter, and polycarbonate shield.

#### **9-31.2 RESERVED**

#### **9-31.3 WIRE**

Street light wire size and type shall be constructed per the Drawings.

Street light wire in conduits shall meet the requirements of SCL Material Standard 6122.30. Wire size shall be indicated on the Drawings.

Wire used inside of poles and bracket arms (including wood pole mounted bracket arms) or bonded to signal spanwires shall meet the requirements of SCL Material Standard 6404.40.

Duplex wire shall meet the requirements of SCL Material Standard 6404.40.

Triplex wire shall meet the requirements of SCL Material Standard 6007.50. Color coding shall not be required for triplex wire.

Multiple conductors shall be color coded in accordance with the NEC. Wire shall be continuously color coded. Neutral wire shall always be white. Grounding conductors shall be green and insulated. The first hot conductor shall be black, the second hot conductor shall be red, and the third hot conductor shall be blue.

Trench ground wire shall conform to SCL Material Standard 6102.20.

Plastic molding for covering wire attached to the side of wood poles shall be in accordance with SCL Material Standard 5820.50.

#### **9-31.4 RESERVED**

#### **9-31.5 WIRE SPLICES**

This standard applies to wire connections made in above grade or below grade installations except where the wires are attached directly to the terminal board. All connectors shall be U.L. or equivalent, labeled and approved for the intended use.

1. **Above Grade Installations** (Including connections in pole handholes):
  - a. Copper to Copper Connector - The connector shall be a high strength bronze alloy of the split bolt type specified in SCL Material Standard 6688.7.
  - b. Copper to Aluminum Connector - The connector shall be of the one or two bolt type labeled CO/ALR and include an approved spacer bar.
  - c. Aluminum to Aluminum Connector - The connector shall be of the 1 or 2 bolt type and meet the requirements of SCL Material Standard 6693.5.
  - d. Split bolt connections shall be insulated in accordance with Section 8-30.3(5).
2. **Below Grade Installations** (Including on Structures):
  - a. Below grade splices shall be made in a 2 piece rigid body transparent moisture proof spliced enclosure. The body shall be webbed to ensure centering of the splice and even distribution of the encapsulant. The body and encapsulant shall be composed of Material which do not support fungi or mold. The encapsulant shall be a reenterable (gel like), transparent type. (Non-reenterable encapsulant may be approved if each splice is approved by the Engineer prior to installing encapsulant.)
  - b. Connectors shall be as described in "a" above, or a copper mechanical crimp type may be used when submitted to, and allowed by, the Engineer at least 3 Working Days in advance of proposed use, or when indicated on a submitted and reviewed by the Engineer Shop Drawing. Mechanical crimp splices shall be made with an approved crimping tool.
3. **Inside Cabinets and Panels:** Wire nuts may be used only inside cabinets and panels. Copper or silver plated terminals shall be used at terminal blocks.

**9-31.6 FUSES AND FUSE HOLDERS**

Fuses shall be of the voltage and amperage specified on the Drawings.

Fuses shall meet the requirements of SCL Material Standard 6855.50

Fuse holders and insulating boots shall meet the requirements of SCL Material Standards 6857.05. Fuse holders shall be crimp-type terminations and be sized appropriately for wire and fuse size.

Fuse, fuse holders, and insulating boots shall be UL-listed for the intended application.

**9-31.7 GROUND RODS, CLAMPS, AND HARDWARE**

Ground rods, couplings, and driving studs shall meet the requirements of SCL Material Standard 5642.10, except the dimension shall be 5/8-inch by 10-feet.

Ground rod clamps shall meet the requirements of SCL Material Standard 5640.30.

Ground plates shall be a minimum of 2 square feet surface area copper plate.

**9-31.8 ENCLOSURES**

Enclosures located outside shall be weather-proof type, NEMA Type 3R. All doors and covers shall be gasketed. All enclosure metal shall be formed of stainless steel or aluminum as noted on the Standard Plans, and shall be constructed to the dimensions shown on the Drawings. All doors shall be provided with a heavy duty hasp suitable for padlocking.

All joints shall be seam welded. Enclosures shall be fabricated to allow for anchor bolt mounting.

A permanent sign shall be attached to the exterior of the enclosure cover or door. The sign shall be engraved into a 2 inch x 6 inch stainless steel plate with a minimum thickness of 18 gauge. The lettering shall be in 3 lines as follows:

**DANGER  
HIGH VOLTAGE  
KEEP OUT**

The letters shall be 1/2 inch high with a stroke width of 3/32 inch, and shall be filled with a red paint.

The completed sign shall be coated with a clear polyurethane enamel with exterior catalyst and attached to the enclosure cover with a minimum of 6 stainless steel drive rivets.

**9-31.9 RECEPTACLES**

Festoon receptacles shall meet the requirements of SCL Material Standard 7330.00. Festoon receptacle shall be 20 amp, 125 volt, AC, GFCI, Hospital Grade receptacles NEMA configuration 5-20R, to be UL listed "Hospital Grade" under UL No. 498.

**SECTION 9-32 TRAFFIC SIGNALS SYSTEM****9-32.1 RESERVED****9-32.2 RESERVED****9-32.3 SIGNAL HEADS, VEHICLE****9-32.3(1) GENERAL****9-32.3(1)A SIGNAL HEAD COMPONENTS**

Signal heads shall be in accordance with the "Institute of Transportation Engineers" publication, current edition of "ADJUSTABLE FACE VEHICLE TRAFFIC CONTROL SIGNAL HEAD STANDARD" and the following additional requirements:

The equipment shall be designed for operation under temperature and humidity conditions encountered in the Pacific Northwestern United States.

Materials and workmanship shall conform to the best commercial standards of the industry.

Signal hanger pins shall include a stainless steel washer between each cotter key and the signal hanger.

A terminal block of an approved type shall be mounted inside at the back of each signal head. It shall have sufficient studs to terminate six (6) lamp wires independently to six (6) field wires. The screws shall be of sufficient length to easily accommodate 14 AWG field wires without having to remove the screws. The terminals to which field wires are attached shall be permanently tagged to facilitate field work. Lamp socket wires shall consist of a white wire and a wire of the same color as the lens connected to the terminal block.

All signal heads shall be installed as indicated on the Drawings.

The housing, door, visor exterior and mounting hardware/framework shall be dark green in color. The visor interior and both sides of the back plate shall be optical black or flat black in color. The paint shall be of the best quality synthetic resin enamel.

Adjustable signal heads shall consist of separate signal sections, expandable type, for vertical or horizontal mounting, rigidly and securely fastened together into one weather-tight signal assembly. The signal sections shall be 8 inches or 12 inches in diameter, as indicated on the Drawings.

Each section shall consist of a housing, door assembly, Light Emitting Diode (LED) technology module optical unit and backplate and shall be so constructed as to provide complete interchangeability of parts.

Weather-resistant mildew-proof gasketing shall be provided between the housing and door assembly and between the lens and LED module, which shall exclude dust and moisture.

#### **9-32.3(1)B HOUSING**

The housing shall be cast aluminum alloy, free of flaws, cracks, blowholes and other imperfections.

Each vehicular signal head shall have a 1/4 inch drain hole in the bottom of the head.

Each section shall house 1 individual optical unit complete with 1-piece hinged square door, mounting for the lens and other parts of the optical system and a simple noncorrodible door-locking device.

Sections shall be interchangeable and so constructed that sections can be added or removed. The top and bottom shall be drilled for 1-1/2 inch supporting pipe fittings. Hexagonal heavy plumbers lock nuts 2-1/2 inches across flats for 1-1/2 inch pipe shall be provided for top and bottom.

The 4 backplate mounting holes (2 in the top of the backplate and 2 in the bottom of the backplate) shall be a maximum distance of 1-1/4 inches on 8 inch signal and 2-1/2 inches on 12 inch signals from the top or bottom edge of the signal housing.

#### **9-32.3(1)C DOOR ASSEMBLY**

The door assembly shall consist of the door, lens and visor.

The door of each section shall be made of aluminum alloy and shall be hinged to the housing so as to permit access or removal. The door shall be secured to the housing by a single finger type locking device. The door-locking device shall be easily removable to allow door removal.

Each section shall have a visor made from aluminum alloy sheet of a tunnel design attached to the door by means of 4 panhead screws. The mounting holes shall be slotted. Visor length shall be 8 inches for 8 inch signals and 12 inches for 12 inch signals.

The lens shall be glass, circular in shape of the color, type and size specified. The lens shall be designed to give an outward distribution of light with a minimum above the horizontal. Each lens shall be true to color and shall conform to the current ITE Standard. The lenses shall have a minimum visible diameter of 7-3/4 inches (eight inches nominal) or 11-1/2 inches (12 inches nominal).

#### **9-32.3(1)D OPTICAL UNIT**

All vehicle signal head sections shall be provided with an expanded view Light Emitting Diode (LED) technology rather than incandescent unless otherwise specified in the Contract. A sample of the LED module to be used, the manufacturer's specifications, and a Manufacturer's Certificate of Compliance to the VTCSH specifications shall be provided to the Engineer for approval. If approved, the LED sample submitted will then be used as the basis for accepting all further units to be installed. Written approval by the Engineer will be required prior to the first installation.

LED modules shall fit into traffic signal housings built to the VTCSH standards without modification to the housing and shall not require special tools for installation. It shall be weather tight and fit securely in the housing and shall connect directly to the electrical wiring terminals.

The lens Materials to enhance ON/OFF contrasts shall not affect luminous intensity or chromaticity and shall be uniform across the face of the lens and shall be UV stabilized. The lens shall be a replaceable part without the need to replace the complete module.

The module shall be a single, self-contained device, not requiring on site assembly for installation and with its power supply packaged within the module enclosure and shall be completely protected against dust and moisture intrusion as per NEMA Standard 250-1991 requirements, for Type 4 enclosures to protect all internal LED, electronic, and electrical components.

The LED signal module shall be rated for use in the ambient operating temperature range of -40°C (-40°F) to +74°C (+165°F).

The LED signal modules when operated at nominal voltage and 25°C (77°F) shall provide a power factor of 0.90 or greater and a total harmonic distortion not to exceed 20 percent on modules with power consumption of 15 watts or greater, and 40 percent for modules with power consumption of less than 15 watts.

All electronic components shall be adequately supported to withstand mechanical shock and vibration from high winds and other sources. Materials used for the module enclosure shall be made of UL94VO flame retardant with the exception of the lens. The lens shall have no scratches (abrasions), cracks, chips, discoloration, or other defects. Any such defects shall be cause for rejection.

Each individual LED signal module shall be identified for warranty purposes, nominal operating voltage, power consumption, volt-ampere and a vertical indexing indicator for correct orientation.

The minimum luminous intensity throughout its useful life and at the end of the warranty period, shall not be less than the values shown in Table 1 Section 4.1 of the latest edition of the ITE Specifications for LED traffic signal modules. When operating within the temperature range specified in Section 3.3.1 during the warranty period, the maximum luminous intensity shall not exceed 800 candelas for the red.

The electrical, wiring and terminal blocks shall meet the requirements of section 13.02 of the VTCSH standard. Fluctuations in line voltage over the range of 80VAC to 135VAC shall not affect luminous intensity by more than  $\pm 10$  percent. The circuitry shall prevent perceptible flicker and include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992. A catastrophic failure of one LED light source shall result in the loss of not more than 5 percent of the signal module light output. The module shall be operationally compatible with NEMA (TS-1 or later) load switches. All LEDs shall be of the AllnGap technology or proven equal in brightness and bulb life.

Manufacturers shall replace or repair an LED module that fails to function as intended due to workmanship or Materials defects, or if it exhibits luminous intensity of less than the minimum values specified within the first 60 months from the date of installation.

**Written Warranty:** In addition to the requirements of Section 1-05.10, the manufacturer shall provide a written warranty against defects in materials and workmanship for the LED vehicle signal modules for a period of 60 months, and against loss of intensity below 50% of original values for a period of 36 months. This warranty shall become effective after installation of the modules and acceptance by the Engineer.

#### **9-32.3(1)E BACKPLATE**

The signal, with backplate, shall be designed to meet or exceed the load requirements in accordance with Section 2 of "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals", AASHTO current edition. Back plates shall be furnished and attached to each signal head assembly. Back plates shall be louvered type to reduce wind loading, constructed of anodized, 3-S half-hard aluminum sheet, 0.058 inches minimum thickness. The back plates shall be riveted together with a minimum of 8 5/16 inch stainless steel pop rivets. No bolts or screws will be permitted. Back plates shall not interfere with either the operation of the door or the mounting of the signal. Mounting hole pattern shall match pattern on signal head housing. The front and back of the back plates shall be finished with 2 coats of flat black enamel.

Back plates shall be permanently attached so as to provide a 5 inch border for either 8 inch or 12 inch signal heads. On combination heads (i.e., 12 inch and 8 inch sections) the back plate shall have a 5 inch border relative to the 8 inch head. Therefore, the border on the 12 inch head shall be approximately 3 inches.

Back plates shall be provided with a minimum of 2 mounting holes per signal section, one on each side. The 2 top and 2 bottom backplate mounting holes shall be a maximum distance of 1-1/4 inch from the corners of an 8 inch signal housing, and 2-1/2 inch from the corners of a 12 inch signal housing.

#### **9-32.3(2) BI-MODAL VEHICLE SIGNALS SECTION**

The signal section shall display both yellow and green arrow indications from the same face and shall use a fail-safe 2-lamp system to direct light of either color into a fiberoptic display. The section shall be adaptable to conventional 12 inch vehicle signal heads.

#### **9-32.3(3) RESERVED**

#### **9-32.3(4) DIRECTIONAL LOUVERS**

Where so indicated on the Drawings, louvers shall be furnished and installed in signal visors. Directional louvers shall be so constructed as to have a snug fit in the signal visor. The outside cylinder shall be constructed of No. 22 U.S. gauge sheet steel, and the vanes shall be constructed of No. 27 U.S. gauge sheet steel. Dimensions and arrangement of vanes shall be as indicated on the Drawings.

Louvers shall be galvanized after fabrication by the hot dipped process in conformance with ASTM A 153 and painted flat black.

#### **9-32.3(5) RESERVED**

#### **9-32.4 SIGNAL HEADS, PEDESTRIAN**

##### **9-32.4(1) GENERAL**

Pedestrian signal heads shall conform to the current version of "Pedestrian Traffic Control Signal Indications" published in the "Equipment and Materials Standards of the Institute of Transportation Engineers", ("PTCSI") and in the Applicable Sections of the current version of the "Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)," as modified and adopted by the Washington Department of Transportation (WSDOT); see Section 4E. Current versions are the versions in effect on the Day the Work was advertised for Bids by the Owner.

Pedestrian signal head shall consist of a Light Emitting Diode (LED) message module, case, eggcrate visor, and directional louvers.

The maximum overall dimension of the signal shall be 19-1/2 inches wide, 19 inches high and 9 inches deep, not including eggcrate visor and hinges. In order to facilitate installation and maintenance, the signal shall be designed so that all components are readily accessible from the front by merely opening the signal door.

**Written Warranty:** In addition to the requirements of Section 1-05.10, the manufacturer shall provide a written warranty against defects in materials and workmanship for the entire pedestrian signal including LED message module, and all Acrylonitril Butadiene Styrene (ABS) or polycarbonate plastic parts for a period of 60 months from the date of delivery.

**9-32.4(2) MESSAGE MODULE**

Light Emitting Diode (LED) Pedestrian Traffic Signal with Countdown Feature.

The Pedestrian Signal Display shall consist of a Light Emitting Diode (LED) message module, case, eggcrate visor, and directional louvers; and shall be in conformance with the PTCSI and MUTCD. The case, sun shield and mounting hardware shall be painted dark green in color. The eggcrate visor interior and directional louvers shall be painted flat black in color.

Pedestrian signals shall display international symbols (Portland orange "Hand" and the lunar white "Walking Person") and numerical countdown (Portland orange "digit portion") LED's encased in a molded plug-in plastic message module. The LED module shall have a visual appearance of the display shall be similar to that of an incandescent lamp (i.e., smooth and non-pixelated). The Hand & Walking Person symbols shall be a minimum of 12 inches in height and 7 inches in width.

LED pedestrian and countdown signal module shall be made of UL94 flame-retardant materials. The lens is excluded from this requirement. The lens of the LED pedestrian and countdown signal module shall be polycarbonate UV stabilized and the exterior of the lens shall be uniform and frosted to reduce sun phantom effect.

All pedestrian and countdown signal display modules shall be the Light Emitting Diode (LED) type. Pedestrian and countdown LED traffic signal modules shall be designed such that they can be used as a retrofit replacement for optical units in Standard Plan no. 520 pedestrian signal housing and shall not require special tools for installation. The installation of an LED pedestrian and countdown signal module shall not require modification to the City of Seattle standard housings built to PTCSI standards.

The Walking Person, Hand icons and Countdown digits (16" x 18" module size) shall be incandescent looking and fit within a traffic signal housing built to the Pedestrian Traffic Control Signal Indication (PTCSI) standards. The numbers 00 to 99 on the numerical display shall be side by side, not offset, and shall have a 7" wide x 9" high area for the countdown numerals.

LED pedestrian and countdown signal modules shall be weather tight, fit securely in the housing and shall connect directly to existing electrical wiring. Installation of a replacement LED module into the existing pedestrian housing shall only require the removal of the existing optical unit components, i.e., lens, lamp, gaskets, and reflector. Each LED pedestrian and countdown signal module shall be a single, self-contained device, not requiring on-site assembly for installation into any City of Seattle standard pedestrian signal housing; and shall include an insulated gasket. However, the power supply for the LED pedestrian signal module may be packaged as a separate module. The LED pedestrian and countdown signal modules shall be operationally compatible with the traffic signal controllers and conflict monitors existing at the Project Site

The LED pedestrian and countdown signal module shall be rated for use in the ambient operating temperature range of -40° F to 165° F. Each LED pedestrian signal module shall be protected against dust and moisture intrusion in compliance with MIL-STD-810F Procedure 1, Rain & Blowing Wind. The assembly, manufacturing, and mounting of the LED pedestrian signal module shall be designed to assure all internal LED and electronic components are adequately supported to withstand mechanical shock and vibration from high winds and other live loading sources in compliance with MIL-STD-883 Test Method 2007.

LED pedestrian and countdown signal modules shall operate at a maximum power consumption of 11 Watts for Hand, 8 watts for Walking Person and 6 watts for Countdown (Display "88"). Each LED pedestrian and countdown signal module shall operate from a 60±3 Hz AC line over a range of 80VAC to 135VAC. Nominal operating voltage for all measurement shall be 120±3 volts rms. The LED circuitry shall prevent flicker at less than 100 Hz over the specified voltage range. Fluctuations in the specified line voltage shall not affect luminous intensity by more than ±10%. The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition high-energy transients as stated in Section 2.1.6, NEMA Standard TS-2, 1992. The individual LED light sources shall be wired so that catastrophic failure of one LED shall not result in the loss of more than the light from that one LED. The LED pedestrian and countdown signal modules shall provide a power factor of 0.90 or greater when operated at nominal voltage and at 77 degrees F. Total harmonic distortion induced into an AC power line by the LED pedestrian and countdown signal module shall not exceed 20% when operated at nominal voltage and at 77 degrees F.

LED Countdown modules shall have two separate power supplies for power the Walking Person and Hand icons. The circuitry shall be unrelated to power the LED Walking Person and Hand icons in order to substantially eliminate the risk of displaying the wrong icon.

A sample of the LED module to be used, the manufacturer's specifications, the warranties specified in this Section, a Manufacturer's Certificate of Compliance indicating Specifications are met, and the Requirements Checklist by Manufacturer chart below, shall be submitted to the Engineer for approval. Included in the submittal shall be the manufacturer's recommendations for how the Contractor permanently marks the date of installation on the outside plate. If approved, the sample will then be held for comparison to the remainder of the units to be installed. The approved sample will be allowed for use as the last LED installation.

Requirements Checklist to be filled out by Manufacturer to demonstrate compliance

REQUIREMENT	COMPLY
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The LED module (16" x 18") shall have a visual appearance similar to that of an incandescent lamp (ie, Smooth and Non-Pixelated).	
The numbers 00 to 99 on the numerical display shall be side by side, not offset, and shall have a 7" wide x 9" high area for the countdown numerals.	
The display of seconds remaining shall begin only at the beginning of the clearance interval. After zero, the display shall remain dark until next countdown.	
Manufacturer shall warrant the product with replacement or repair of a pedestrian signal including LED message module that fails due to workmanship or materials within five years from date of delivery.	
For a period of five years, the maintained minimum luminance values for the module shall not be: 2,200 cd/SqM for Walking Person, and 1,400 cd/SqM for Hand & Countdown displays.	
Default condition: for abnormal conditions when nominal voltage to the unit across the two phase wires (rather than being applied to the phase & neutral wires) the unit shall default to the Hand display.	
The Maximum power consumption: 11 watts for Hand, 8 watts for Walking Person, and 6 watts for Countdown (when display is "88").	
The units shall not have any external attachments, dip switches, or options that will allow the mode to be changes from counting the clearance cycle to the full walk/don't walk cycle.	
Provide Model Number	

The manufacturer's name, trademark, operating characteristics, i.e., rated voltage, power consumption, and volt-ampere, and serial number shall be permanently marked on the outside surface of the back of the LED pedestrian and countdown signal module including a permanently attached label or extra blank space that can be permanently marked with the date of installation of the module by the Contractor.

The LED pedestrian and countdown signal modules shall be manufactured in accordance with a Vendor quality assurance (QA) program including both design and production quality assurance. All QA process and test result documentation shall be kept on file for a minimum of five years.

#### **9-32.4(3) CASE**

The case shall consist of a housing and door each made from 1 piece, aluminum alloy die casting. It shall be dustproof, weatherproof and corrosion resistant and shall provide for easy access to and replacement of all components. The housing shall have an integral cast top, bottom, sides, and back. Four integrally cast hinge lug pairs shall be provided for operation of a swing down door.

The housing shall be suitable for left or right hand (with pre-drilled holes and rubber plugs) clamshell mounting hardware, post-top mounting, or bracket mounting.

The top and bottom of the housing shall have an opening to accommodate 1-1/2 inch pipe brackets. The bottom opening of the signal housing shall have a standard 72 tooth locking boss integrally cast into the case. The teeth shall be clean and sharp and provide full engagement. The radial angular grooves of the boss shall provide positive positioning of the entire signal to eliminate rotation or misalignment of the signal.

The door shall be attached to the case by means of 2 stainless steel spring pins. 2 stainless steel hinged bolts with captive stainless steel wingnuts and washers shall be attached to the case with the use of stainless steel spring pins. Hence, latching or unlatching of the door shall require no tools.

A 1/4 inch drain hole shall be provided in the bottom of the case. All unused openings shall be capped with corrosion-resistant metal caps, and weatherproofed with approved washers.

Clamshell mounting shall be a two-piece cast aluminum alloy assembly. One piece shall be the pole "half", the other piece the signal housing "half". The clamshell assembly shall have two integrally cast hinge lug pairs so, that when the clamshell is mounted in final position for pedestrian traffic, the clamshell shall rotate horizontally to the open position for easy access to the control wiring inside the clamshell.

#### **9-32.4(4) EGGCRATE VISOR**

Each signal shall be provided with an eggcrate type visor designed to eliminate sun phantom.

The eggcrate type visor shall be installed parallel to the face of the Hand - Person message lens and shall be held in place by stainless steel screws. The eggcrate assembly shall consist of vertical members and horizontal members. The completed assembly shall be approximately 1-1/2 inches deep.



The basic Material used in construction of the eggcrate shall be nominally 0.030 inches thick polycarbonate plastic. Additional members may be employed outside the two legend areas but are not required unless needed to develop the full potential structural strength attainable through the particular assembly technique employed.

The assembly shall be enclosed in a mounting frame constructed of 0.040 inches minimum thickness aluminum or polycarbonate plastic. This frame shall be approximately 1-1/2 inches deep and may contain alternate mounting holes for use on alternate types of pedestrian signals.

#### **9-32.4(5) RESERVED**

#### **9-32.4(6) RESERVED**

### **9-32.5 PEDESTRIAN PUSHBUTTON ASSEMBLY**

The complete pushbutton assembly shall include the following components:

1. The frame assembly shall consist of an integral pushbutton mount and sign platform and shall be cast aluminum and powder coat finished with the manufacturer's specified black color. The frame assembly shall consist of a backplate to accept a 5-inch by 7-inch sign secured with metal screws, and a round housing with pre-drilled holes to mount the pushbutton assembly.
2. The pushbutton housing shall be die-cast aluminum, round body of approximately 3-inches diameter, and powder coat finished with the manufacturer's specified black color.
3. The pushbutton shall be stainless steel, with a raised tactile directional arrow on the pushbutton. The manufacturer shall provide arrow options of: Left, Right, Up, and bi-directional Left and Right.
4. The pushbutton assembly shall include a Latching Mode with an LED indicator light that will stay "ON" and a percussive beeper for audible feedback. The LED and beeper shall be actuated each time the pushbutton is pressed and shall terminate at the beginning of the pedestrian walk phase.
5. The sign shall be an MUTCD R10-3 and size shall be 5 inch by 7 inch.

The complete pushbutton assembly shall have the following characteristics:

- 1) Vandal resistant construction;
- 2) NEMA 250-6P or IP-68 enclosure protection rating;
- 3) NEMA TS-2 compliance for temperature and humidity, transient voltage protection, and mechanical shock and vibration rating;
- 4) IEC 61000-4-4 and IEC 61000-4-5 compliance for transient suppression;
- 5) 3-year minimum warranty;

### **9-32.6 DETECTOR LOOPS**

Detectors shall be used for actuating traffic-actuated controllers and sample stations. A complete detector loop installation shall consist of loop wire and lead-in cable from the loop to the amplifier. Loop wires and lead-in cables shall be 600 volt rated.

Loop wire in concrete pavement shall be either #14 AWG USE or IMSA 51-3. Loop wire in asphalt pavement shall be IMSA 51-7 with either black PVC or polyethylene tube.

The lead-in from the detector junction box to the controller cabinet or remote amplifier cabinet shall be either three pair #16 AWG 7x24, or 6 pair #16 AWG 7x24 stranded tinned copper, polyvinyl chloride/nylon individual insulated, overall PVC jacketed, twisted pair cable(s) with aluminum foil-polyester shield. The three pair and the six pair lead-in cables shall have a #18 AWG stranded tinned-copper drain wire. The conductors shall be twisted together approximately 3 turns per foot. Connections of the loop wire to the lead-in wire shall be made only in a handhole with a waterproof splice as indicated on the Drawings.

### **9-32.7 ILLUMINATED SIGN**

The equipment shall be designed and manufactured for operation under temperature and humidity conditions encountered in the Pacific Northwestern United States.

The sign, when mounted, shall be designed to meet or exceed the load requirements in accordance with Section 2 of "Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals", AASHTO current edition.

The sign size shall be as indicated on the Drawings. The housing shall be a double faced design made of extruded aluminum alloy or polyvinyl, dark green in color or with a brushed aluminum finish. The interior shall be painted white.

Standard signal mounting hardware shall be used to mount illuminated signs to all street furniture. The sign shall be fitted with a 1-1/2 inch iron pipe (IP) with tapped straight thread hub on top, for mast arm and span wire mount, and on top and bottom for bracket mount.

The front message panel shall be translucent white Rohm and Haas Plexiglass, or Tuflite white fiberglass, or equal. The back message panel shall be constructed of aluminum alloy or polyvinyl, colored dark green or brushed aluminum finish to match the housing, unless the sign is double faced in which case it shall be the same as the front message panel. Sign message shall be as indicated on the Drawings.

A terminal block for power input hookup shall be accessible by opening either message panel.

Signs shall be completely wired and assembled.

Unless otherwise indicated in the Contract, the sign shall be equipped with 4-24 inch T12-CW fluorescent tubes with weatherproof tube type sockets and ballast transformer. The ballast transformer shall be non-flashing 425 mil-amp type, 0°F starting, 120 VAC, 60 Hz.

Hardware (i.e., rivets, screws, bolts, nuts, etc.) and non-aluminum parts shall be stainless steel.

Each interior illuminated sign assembly shall be fused. All fuses shall be accessible by opening either of the message panels. Both message panels shall be of the sliding type with stop bars to prevent total removal, and for ease of maintenance.

### **9-32.8 EMERGENCY VEHICLE PREEMPTION**

All emergency vehicle preemption detectors shall be Opticom™, without substitution. All detector wiring shall be Opticom™, Model 138, shielded detector cable, without substitution, and shall meet International Municipal Signal Association (IMSA) specification 51-5.

#### **9-32.8(1) OPTICOM DISCRIMINATORS**

The Contractor shall furnish and install Opticom™, Model 752, discriminators, without substitution, in the control cabinets when called for on the Drawings.

### **9-32.9 INTERCONNECT CABLE**

#### **9-32.9(1) UNDERGROUND**

Interconnect cable (UIC) shall be #19 or #22 solid aerial/duct communication cable and shall conform to REA Specification PE-39 or I.M.S.A. Specification No. 20-2. The number of pairs and size shall be as indicated on the Drawings.

#### **9-32.9(2) AERIAL ("FIGURE 8")**

Interconnect cable (AIC) shall be #19 or #22 solid "figure 8" communication cable and shall conform to REA specification PE-38, or I.M.S.A. specification no. 20-4. The number of pairs and size shall be as indicated on the Drawings.

#### **9-32.9(3) INDOOR**

Interconnect cable shall be #19 or #22 multiple pair communications cable and conform to REA specification PE-22, or I.M.S.A. specification no. 20-2. The number of pairs and size shall be as indicated on the Drawings.

### **9-32.10 RESERVED**

### **9-32.11 SIGNAL WIRING**

#### **9-32.11(1) TRAFFIC SIGNAL CABLE**

<b>COLOR CODE BASE/TRACER</b>	<b>1c</b>	<b>2c</b>	<b>3c</b>	<b>5c</b>	<b>7c</b>	<b>10c</b>	<b>13c</b>
Black	#12	#14	#14	#14	#14	#14	#14
White	---	#14	#14	#14	#14	#14	#14
Red	---	---	#14	#14	#14	#14	#14
Green	---	---	---	#14	#14	#14	#14
Orange	---	---	---	#14	#14	#14	#14
Blue	---	---	---	---	#14	#14	#14
White/Black	---	---	---	---	#14	#14	#14
Red/Black	---	---	---	---	---	#14	#14
Green/Black	---	---	---	---	---	#14	#14
Orange/Black	---	---	---	---	---	#14	#14

Signal Cable shall have stranded copper conductors and shall conform to I.M.S.A. specification No. 20-1 (polyethylene insulated, polyethylene jacketed signal cable).

#### **9-32.11(2) PEDESTRIAN PUSHBUTTON CABLE**

Pedestrian pushbutton cable shall be single pair #16 AWG 19x29 stranded copper, polyethylene insulated, PVC jacketed, twisted pair cable with copper or aluminum-polyester shield and a No. 18 AWG stranded tinned-copper drain wire. The conductors shall be twisted together approximately 3 turns per foot.

#### **9-32.11(3) ELECTRICAL SERVICE CONNECTIONS**

All traffic signal services shall be 2 parallel 120 volt, 60 HZ AC electrical services with accompanying equipment.

Individual service conductors shall be color or number coded type XHHW or THWN No. 8 AWG stranded copper. The outer jacket of cable shall be flame retardant, moisture, heat and sun light resistant thermoplastic or cross linked synthetic polymer suitable for underground conduit or aerial installation with suitable non-hygroscopic fillers.

All final connections and energizing of signal systems (overhead secondary or secondary in vaults or handholes) shall be performed by Seattle City Light.

#### 9-32.11(4) FUSES AND FUSE BLOCKS

See Section 9-31.6.

#### 9-32.11(5) POLE JUNCTION BOXES OR TERMINAL CABINETS

Junction boxes or terminal cabinets shall conform to NEMA 4 requirements.

1. Junction boxes or terminal cabinets shall be constructed of welded 14 gage (minimum) hot-dipped galvanized sheet steel, 14-gage, minimum type 316 stainless steel or 0.125 inch, minimum 5052 alloy aluminum H32 ASTM designator minimum.
2. Nominal Junction boxes or terminal cabinets dimensions shall be:
 

	Depth	Height	Width
a.	8"	16"	12"
b.	8"	24"	18"
3. The doors shall have two stainless steel piano hinges. The door shall also be provided with a spring loaded construction core lock capable of accepting a Best six pin CX series core. The locking mechanism shall provide a tapered bolt. The Contractor shall supply construction cores with two master keys. The keys shall be delivered to the Engineer.
4. All seams shall be continuously welded.
5. Junction boxes or terminal cabinets shall provide a gasketed door flange.
6. One spare 12-position terminal block shall be installed.
7. Each Junction box or terminal cabinet shall have 1/8-inch drain holes in back corners.

#### 9-32.11(6) GROUND RODS, CLAMPS AND BONDING

See Section 9-31.7.

#### 9-32.11(7) SQUEEZE CABLE FITTINGS

Cable fittings for entry of cable through metal walls of poles, signs and signals shall be squeeze-type cable fittings with water-tight neoprene bushings. Size shall be carefully chosen to match the cable diameter to assure a water-tight fitting without damaging the cable.

#### 9-32.12 SPAN WIRE

Span wire shall be 5/16 inch, 7-strand aluminum covered steel span wire conforming to ASTM B 415 with rated breaking strength of 10,270 lbs. in accordance with SCL Material Standard No. 5664.1.

Catenary span wire shall be 7/16 inch, 7-strand aluminum covered steel span wire conforming to ASTM B 415 with rated breaking strength of 20,800 lbs. in accordance with SCL Material Standard No. 5664.1.

#### 9-32.13 POLE LINE HARDWARE

Strain insulators shall be wet process, porcelain, conforming to EEI-NEMA TDJ-54 as follows:

5/16 inch wire	Class 54-2
7/16 inch wire	Class 54-3

Tether wire shall be 1/8 inch galvanized steel stranded wire conforming to ASTM A 475, extra high strength grade (rated at 1500 pounds minimum), Class A galvanized.

Bull rings (purse seine rings) shall be low carbon steel with an ultimate strength of 25,000 pounds. The ring shall be closed with a weld equal to or greater than 90 percent of the unwelded steel. The ring shall be galvanized with at least 2 ounces of zinc per square foot, which is equivalent to 3 mils of thickness. The steel shall be 3/4 inches in diameter and shall form a ring with a 3 inch ID. Higher strength steel shall be used when more than 4 signal heads are being supported.

All pole hardware, bolts, plate rods, hangers, clamps, wire guards and pole bands shall be hot-dipped galvanized in conformance with the requirements of ASTM A 153, or shall be stainless steel.

All miscellaneous pole line hardware required to complete the Project as planned shall be standard Material manufactured for pole line construction.

Pole band assembly shall consist of four (4) band sections and shall be four (4) way adjustable mounting connection on four (4) sides. Each band shall have four (4) 3/4-inch diameter all threaded studs and four (4) 3/4-inch regular nuts per stud (total 16 nuts per assembly). Pole band assembly shall have 20,000 pounds ultimate tensile strength. All parts of the pole band shall be hot-dipped galvanized in conformance with the requirements of ASTM A153.

**9-32.14 GALVANIZING REPAIR PAINT**

Field repair of galvanized surfaces shall be a coating of heated zinc alloy solder to a minimum thickness of 2 mils in accordance with ASTM A 780.

**SECTION 9-33 POLES, PEDESTALS, AND FOUNDATIONS****9-33.1 GENERAL****9-33.1(1) POLES, MAST ARMS, AND BRACKET ARMS**

All metal poles, mast arms and bracket arms shall be designed and fabricated to conform with the requirements of AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals", current edition (hereinafter referred to as "AASHTO"), and EEI-TDJ 135 and 139. All load requirements shall be accommodated as indicated on the Standard Plans.

Poles shall be galvanized steel, timber, or aluminum in accordance with the Drawings.

Poles not meeting the requirements of the Drawings and Specifications will be rejected.

**9-33.1(2) ANCHOR BOLTS**

Anchor bolts for light poles (steel or aluminum) shall conform to ASTM A 307 or ASTM A 576, unless otherwise specified in the Contract. Anchor bolts for steel strain poles Type T, and mast arm poles shall conform to ASTM A 576 (Type 1040 or 1045), ASTM A 675 (Gr. 90), or ASTM A 36 Mod, with  $F_y = 55$  ksi minimum. Anchor bolts for steel strain poles Types V, X, Z shall conform to ASTM F 1554-99, Grade 105, Class 2A including supplementary requirements S2, S3 and S5. Each anchor bolt shall have a hexagonal leveling nut with a washer for leveling and a hexagonal nut with a flat washer and a lock washer for the top of the anchor base plate. All anchor bolts (full length), nuts and washers shall be galvanized in accordance with ASTM A 153. Anchor bolts shall not be bent or cut after fabrication. Bending of anchor bolts shall be cause of rejection and removal of entire foundation.

Anchor bolt extenders (sleeve nuts), where required, shall be of a strength greater than the existing anchor bolts. The bolt extenders shall have a hexagonal tightening nut, and shall be galvanized in accordance with ASTM A 153.

**9-33.1(3) GALVANIZING**

Before galvanizing, all sharp edges on welds and cut-ins inside the pole shaft, mast arm and luminaire arms shall be removed or filed smooth to prevent damage to the wires in the pole.

Structural Material shall be zinc-coated by hot-dip process in accordance with ASTM A 123 and the final coating shall measure 0.003 inches or more in thickness as determined by a magnetic thickness gauge. Hardware and appurtenances shall be coated in accordance with ASTM A 153. Threads shall be re-cut after galvanizing without exposing base metal. Galvanizing certification of compliance with the applicable ASTM Standards signed by an ASTM accredited independent testing laboratory shall be submitted to the Engineer before shipment.

The finished pole shall be straight and free from injurious defects. Poles distorted by the galvanizing process shall be straightened without damage to the galvanizing coating. The finish coating shall be smooth and free of dross. After galvanizing, the interior of the pole and arms shall be free from sharp edges to prevent damage to wiring.

**9-33.1(4) GROUND LUGS**

Metal poles shall have a 3/8 inch tapped hole in the bottom edge of the handhole inside the pole. A 3/8 inch stainless steel bolt with stainless steel lock washer suitable for grounding shall be provided.

**9-33.1(5) NUT COVERS**

On light poles, the Contractor shall furnish and install separate nut covers to cover anchor bolts and nuts only (not the base flange). Nut covers shall fit snugly to the bolt. Nut covers shall be made of the same Materials as the pole and shall be provided by the pole manufacturer. Nut covers are not required on steel strain or Chief Seattle base type poles unless specified on the Drawings.

**9-33.1(6) CONCENTRICITY**

Unless otherwise noted on the Drawings, poles, mast arms, and luminaire extensions shall be within plus or minus 1/16 inch of perfect round with a constant taper of approximately 0.14 inches per foot and of uniform thickness.

**9-33.1(7) GROUT**

Grout shall conform to the requirements of Section 9-04.3(2) for non-shrink cement sand grout.

**9-33.2 STEEL POLES, MAST ARMS, BRACKET ARMS, AND LUMINAIRE EXTENSIONS****9-33.2(1) GENERAL**

Poles shall be inspected for Material compliance and acceptance by the Engineer prior to installation.

The term "steel strain pole" as used herein refers to any steel pole subjected to a span wire load (including METRO trolley loads) or mast arm load. Luminaires or other street lighting appurtenances may be mounted on a "steel strain pole". The term "steel lighting pole" refers to any steel pole which carries a luminaire but does not carry a span wire or mast arm load.

The length of the mast arm, height of pole, and size and type of bracket extension shall be as indicated on the Drawings. An aluminum or stainless steel pole identification plate shall be securely attached immediately above the handhole, and shall indicate gauge, manufacturer, bolt circle, design principle moment in kip-feet, length, and date of manufacture.

Outside diameter of pole shafts shall be as indicated in the Standard Plans.

#### **9-33.2(2) STRENGTH AND DEFLECTION REQUIREMENTS**

The pole shaft shall have strength sufficient to support all indicated loads.

The following design loads shall be used: Dead load shall consist of the weight of the signals, luminaires and bracket arms, signs and supporting structure, and associated appurtenances; wind and ice loads shall be as indicated by AASHTO. The signal head mast arm shall be of such size and gauge as to resist the bending moment.

The design of steel strain poles that support overhead trolley loads shall be governed by King County METRO Transit design standards as detailed on the Drawings.

Structural steel having a yield point of 33,000 psi or more shall be used for all structural parts. Silicon content of the steel shall be no more than 0.04 percent to prevent discoloration during galvanizing.

The total deflection at the top of metal poles resulting from all dead loads applied shall not exceed 2.5 percent of pole height.

The deflection of the mast arm after loading shall not cause the end of the mast arm to extend below a horizontal line from the center of the arm flange. The maximum rise of the mast arm after loading from a horizontal line shall be 2 degrees.

The tenon for the luminaire shall be between 1 and 4 degrees above horizontal with the luminaire installed and all other loads applied to the pole.

#### **9-33.2(3) BOLT CIRCLE**

Mast arm flange and pole base bolt circles shall be as indicated on the Standard Plans.

#### **9-33.2(4) WELDS**

Circumferential butt welds shall have permanent back-up rings and full penetration for 100 percent of the circumference. All exposed butt welds shall be ground flush. All welds shall conform to the requirements of Section 6-03.3(25).

#### **9-33.2(5) HANDHOLES, FESTOONS, AND CABLE OUTLETS ON POLES**

Steel poles shall have one oval 4 inch x 6-1/2 inch handhole, as shown in the Standard Plans, reinforced so as to result in no loss of shaft strength. The handhole shall have matching cover attached with stainless steel bolts. The cover shall be rain tight and removable. The handhole shall be fabricated into the pole in a position 90 degrees clockwise from the side on which the bracket or mast arm is attached.

Festoon outlets, when required, shall be as indicated in the Standard Plans.

Cable outlets (on poles) as shown on Standard Plan no. 563b shall be schedule 40 steel pipe extending perpendicularly from the pole. Both ends of the pipe shall be rounded for wire protection. The cable outlet shall be installed, drilled and edges rounded before galvanizing.

#### **9-33.2(6) RESERVED**

#### **9-33.2(7) ANCHOR BASE PLATES**

A one-piece steel anchor base plate shall be secured to the lower end of the shaft by continuous electric arc welds as shown in the Standard Plans. The welded connection shall develop the full strength of the adjacent shaft section.

#### **9-33.2(8) POLE AND MAST ARM CAPS**

All metal poles (except davit poles) and mast arms shall be equipped with a rain-tight pole cap constructed of the same Material as the pole, and attached with stainless steel bolts.

#### **9-33.2(9) BRACKET ARMS**

Bracket arms shall be per SCL Material Standard 5705.1 or 5705.2 or manufactured as indicated on the Standard Plans and in accordance with AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals", current edition, to support a luminaire of 50 pounds, a 1.2 square foot effective projected area for an 80 mph wind and a coefficient of height of 1.10.

Bracket arm hardware shall include the bolts, nuts and washers galvanized for wood and steel poles and stainless steel for aluminum pole types. Bracket arms shall be the same style as depicted on the Drawings. Small differences in dimensions may be acceptable to the Engineer when structural calculations accompany these indicated dimension differences on the Shop Drawings (see Section 1-05.3(12)).

Bracket arms shall accommodate the luminaire slipfitter attachment. The terminal end of the arm shall be a straight, tubular section with external dimensions of 2 inches NPS by 6-1/2 inches long.

Bracket arms mounted on metal poles shall be constructed of the same Material as the poles. If the bracket arm and metal pole are of dissimilar metals, they shall be separated by an approved plastic dielectric pad of 5 mils minimum thickness.

The longitudinal axis at the end of the bracket arm shall be not less than 1 degree nor more than 4 degrees above the horizontal with the luminaire installed under load (see Std Plan no. 572).

All tubing used for aluminum bracket arm members shall be seamless, Alloy 6063 - heat treated to T-6 after fabrication. Aluminum bracket arms shall meet the requirements of ANSI C136.13.

### **9-33.3 ALUMINUM POLES**

#### **9-33.3(1) ROADWAY**

Aluminum street light poles for cobra-head style fixtures shall meet the requirements of SCL Material Standard 5750.03, except as modified herein and in the Contract. Aluminum street light poles for pedestrian and decorative style fixtures shall meet the requirements of SCL Material Standard 5752.05, 5754.07, and/or 5756.09, as appropriate.

Anchor bolts for aluminum poles shall be the same as required for steel poles.

#### **9-33.3(2) PEDESTRIAN ROUND**

Round aluminum street light poles for post-top style fixtures shall meet the requirements of SCL Material Standard 5752.05.

#### **9-33.3(3) PEDESTRIAN SQUARE**

Square aluminum street light poles for shoe-box style fixtures shall meet the requirements of SCL Material Standard 5754.07.

#### **9-33.3(4) DECORATIVE**

Decorative aluminum street light poles for decorative post-top style fixtures shall meet the requirements of SCL Material Standard 5756.09.

### **9-33.4 WOOD POLES**

#### **9-33.4(1) GENERAL**

Strain poles shall be either Douglas Fir, class 1, or Western Red Cedar, class 1.

Street light poles shall be Western Red Cedar, class 3.

Poles shall be framed (notched) before treatment with a 1/2 inch deep by 2 inch high setting gain on the pole face, 12 feet from the pole butt.

Poles shall be branded by burning the pole face, as specified by ANSI 05.1, 12 feet, 6 inches above the pole butt. Metal marking tags will not be accepted.

Poles shall be butt-treated in accordance with AWPA C7, and the entire butt section of the pole shall be incised. After framing and roofing, the cuts shall be well brushed with the hot preservative.

#### **9-33.4(2) DOUGLAS FIR**

Douglas fir wood poles shall meet SCL Material Standard 5082.00.

#### **9-33.4(3) WESTERN RED CEDAR**

Western red cedar wood poles shall meet SCL Material Standard 5072.00.

### **9-33.5 RESERVED**

### **9-33.6 STEEL PEDESTALS AND ALUMINUM PEDESTALS**

#### **9-33.6(1) STEEL PEDESTALS**

Shafts shall be constructed of welded structural steel, open-hearth lap welded steel or standard steel pipe conforming to the requirements of ASTM A 53. Shafts shall be 4 inch schedule 40 galvanized steel pipe with threaded end for mounting to the base. The overall height of the shaft and base shall be as indicated on the Drawings.

Pedestal base shall be of cast iron conforming to the requirements of ASTM A 48, Class 40 and made in accordance to the configuration on the Standard Plans. Bases for pedestals shall be threaded, octagonal cast iron equipped with an access door for wiring. A 13-1/2 inch diameter bolt circle size shall be used. The base shall have a grounding lug inside which is accessible from the handhole. The base shall be silver in color.

#### **9-33.6(2) ALUMINUM PEDESTALS**

Shafts shall be 4 inch schedule 80 aluminum pipe with one threaded end for mounting to the base. The overall height of the shaft and base shall be as indicated on the Drawings.

Pedestal base shall be of cast aluminum conforming to the configuration on the Standard Plans. Bases for pedestals shall be threaded, square, aluminum and equipped with an aluminum access door for wiring. A 13-1/2 inch diameter bolt circle size shall be used. The base shall have a grounding lug inside which is accessible from the handhole. The base shall be aluminum in color.

### **9-33.7 PEDESTRIAN PUSHBUTTON POSTS**

Pedestrian pushbutton posts shall be constructed of 2 inch I.D. schedule 40 galvanized steel pipe with length as indicated on the Drawings. The post collar, pipe flange, bolts, nuts and washers shall conform to the details of the Drawings.

### **9-33.8 BACK GUY ASSEMBLIES AND GUY WIRE**

Unless otherwise indicated in the Contract, guy wire shall be 5/16 inch, aluminum covered steel strand wire.

Guy assembly components including the deadend grips, the porcelain strain insulator, and the automatic feed-thru deadend shall be sized so as to meet or exceed the rated breaking strength of guy wire.

Anchors for back guys shall consist of one of the following types:

1. A 4-way or 8-way steel expanding anchor, having a minimum of 300 square inches, made of pressed steel, coated with asphalt or similar preservative and fitted with 3/4 inch minimum guy eye anchor rod 8 feet long.
2. Plate anchor fitted with 3/4 inch minimum guy eye anchor rod 8 feet long.
3. An approved steel screw, such as a power installed steel helix anchor with extension rods, extension rod coupling, and strand eye nut. The steel screw shall be sized based upon its load and soil conditions by the Engineer.

The following components shall conform with the requirements of SCL Material Standards:

COMPONENT	SCL MATERIAL STANDARD
Guy Wire	5664.1
Guy Hook with Integral Spurs	5651.15
Deadend Grip	5651.4
Porcelain Strain Insulator	6901.1
Plastic Wire Guard	5651.8
Automatic Feed-Through Deadend	5650.3
Plate Anchor	5620.7
Single Strand Eye Nut	5652.1
Sidewalk Pipe Guy Fittings	5650.1

The pipe brace shall be galvanized extra strong steel pipe.

## SECTION 9-34 ELECTRICAL AND SIGNAL CONDUITS

### 9-34.1 GENERAL

Conduit shall be PVC coated galvanized rigid steel, galvanized rigid steel, or schedule 80 PVC conforming to Articles 346 (rigid metal conduit) or 347 (rigid nonmetal conduit) of the NEC type and size as indicated on the Drawings. All conduit, elbows, fittings, and accessories shall be UL listed.

Factory bends and elbows shall be utilized in all cases where they provide the required deflection.

Field bends, when required, shall be performed so as to result in no flattening of conduit or damage to the galvanizing or PVC coating.

### 9-34.2 RIGID STEEL CONDUIT

#### 9-34.2(1) GENERAL

Exterior and interior surfaces of all steel conduit, including threads, except field cut threads, shall be uniformly and adequately zinc coated by a hot dip galvanizing process. The average weight of zinc coating shall not be less than 0.80 ounces of zinc per square foot of single surface area as determined by tests on 12 inch samples taken from a standard length of conduit of each size. The weight of zinc coating on any individual test specimen shall be not less than 0.7 ounces of zinc per square foot of single surface area. The weight of zinc coating will be determined in accordance with AASHTO T 65. Determinations and nominal weights shall conform to the requirements of the Underwriters Laboratory Publication No. 6 (current edition). In addition, the exterior as well as the interior conduit samples shall withstand 4 dips in the PREECE test in accordance with ASTM A 239.

Every length of rigid metal conduit shall bear the label of Underwriters Laboratories, Inc., or the label of the Canadian Standards Association, if affected items of Canadian manufacture are approved for use on the project as indicated in the Contract. Installation shall conform to appropriate articles of the NEC.

Rigid steel conduit may be substituted where PVC is indicated on the Drawings at the Contractor's option when approved by the Engineer at no additional expense to the Owner, except on pole risers.

Fittings for field and factory bends shall be identical and interchangeable.

#### 9-34.2(2) THREADS

The exposed thread ends of rigid steel conduit shall be hot dipped galvanized in accordance with the foregoing. Field cut threads shall be painted with galvanized repair paint acceptable to the Engineer.

#### 9-34.2(3) COUPLINGS AND FITTINGS

Couplings and fittings for rigid steel type conduits shall be hot-dip galvanized, with the same quantities of zinc noted above. Couplings shall withstand 4 dips in the PREECE test as specified above.

#### 9-34.2(4) PVC COATING

All galvanized rigid steel conduit shall be PVC (polyvinyl chloride) coated with dark gray, and U.V. resistant type plastic where indicated on the Drawings.

The zinc surface prior to plastic coating shall be conditioned with chromic acid to provide an anchor for the plastic coating.

Both interior and exterior shall be coated with an epoxy acrylic primer not to exceed 0.0005 inches thick prior to the application of the PVC coating.

A PVC coating shall be bonded to the outside of the pipe (excluding the threads) with a thickness between 0.035 inch and 0.045 inch. The PVC coating shall be applied by the plastisol dip method and shall contain ultraviolet inhibitors.

A urethane coating of a nominal 2 mil thickness shall be applied to the interior of all conduits.

A coupling with the same PVC coating shall be furnished loose with each length of conduit and shall have a plastic sleeve extending 1 pipe diameter or 2 inches (whichever is less) beyond the end of the coupling. The inside diameter of the plastic sleeve shall be the same as the outside diameter of uncoated pipe of the same nominal size. The wall thickness of the plastic sleeve shall be the same as the plastic coating on the pipe. The bond between the metal and the PVC coating shall be equal to or greater than the tensile strength of the PVC coating.

All conduit fittings which are hollow and serve as part of the raceway shall be coated with the same coatings on the outside and inside as described above. The fittings shall have PVC sleeves at all female openings similar to the sleeves on the couplings. The coated conduit shall conform to NEMA Standard No. RNI-2005.

All coated conduit brackets, supports, clamps, NEMA 4 junction boxes, drains, breathers, expansion/deflection fittings, seals, etc., shall be PVC coated by the producer of the conduit. Field repair and touch-up shall be made with Materials approved by the Engineer.

#### **9-34.2(5) RESERVED**

#### **9-34.2(6) EXPANSION/DEFLECTION FITTINGS IN NON-HAZARD AREAS**

Expansion/deflection fittings shall be installed in all structural expansion joints. The expansion portion of the set shall provide for 4 inches of movement, 2 inches in each direction, unless specified otherwise on the Drawings. The deflection portion of the set shall provide for a movement of 3/4 inch in all directions, and an angular deflection of 30 degrees from normal in any direction. Fittings shall be O.Z. Gedney Type AXDX or approved equal.

#### **9-34.3 PVC CONDUIT**

Plastic conduit and fittings shall be rigid PVC Type EPC schedule 80.

PVC rigid non-metallic conduit may be used for all installations except the first 10 feet above ground on a pole riser and the adjacent bend, unless specified otherwise in the Contract.

Rigid PVC shall meet the requirements of ASTM D 1785 and ASTM D 2466. The conduit shall be suitable for use above ground, for direct burial, and for corrosive atmosphere areas.

Rigid PVC shall comply with SCL Material Standard 7020.05.

#### **9-34.4 CONDUIT RISER**

Refer to Section 8-33.3(3).

#### **9-34.5 PULL CORD**

Pull cords shall be 1/4 inch polypropylene meeting the requirements of Seattle City Light Material Standard 7272.2.

#### **9-34.6 HANDHOLES**

Handholes shall comply with SCL Material Standard 7203.10.

Installation of polymer concrete handholes must be approved by the Engineer and shall comply with SCL Material Standard 7203.20.

### **SECTION 9-35 ELASTOMERIC BEARING PADS**

Elastomeric bearing pads shall conform to the requirements of AASHTO M 251. The elastomer shall not contain any form of wax.

All bearing pads shall be individually cast with fully molded edges. Corners and edges of molded pads may be rounded at the option of the Contractor. Radius at corners shall not exceed 3/8 inch, and radius of edges shall not exceed 1/8 inch.

Shims contained in laminated bearing pads shall be mill rolled steel sheets not less than 20 gage in thickness with a minimum cover of elastomer on all edges of:

1/8-inch for pads up to 3 inches thick

1/4-inch for pads over 3 inches thick, and

1/2-inch for pads greater than 7-inches thick.

Steel shims shall conform to ASTM A 1011, Grade 36, unless otherwise noted.

The shims shall be spaced to divide the pad thickness into equal laminations. The bond between the elastomer and metal shims shall be such that, when a sample is tested for separation, failure shall occur within the elastomer and not between the elastomer and the metal shim.



The shear modulus at 73°F or the durometer hardness of the bearing pads shall be as noted in the Contract. If durometer hardness is noted, the following shear modulus shall be applicable for shear modulus testing purposes: 50 durometer - 112 psi, 60 durometer-165psi, 70 durometer - 250psi. Elastomer shall be Grade 3.

Elastomeric bearing pads shall be manufactured with the following tolerances:

<b>OVERALL VERTICAL DIMENSIONS:</b>	
Design thickness 1 1/4 inches or less	-0, + 1/8 inch
Design thickness over 1 1/4 inches	-0, + 1/4 inch
<b>OVERALL HORIZONTAL DIMENSIONS:</b>	
36 inches and less	-0, + 1/4 inch
Over 36 inches	-0, + 1/2 inch

## **SECTION 9-36 DETECTABLE WARNING**

### **9-36.1 GENERAL**

The detectable warning plate (cast in place with curb ramp or surface) and the detectable warning plate retrofit (surface applied to existing curb ramp or surface) shall meet the requirements for tactile warning surfaces established by the ADA (Americans with Disability Act) Accessibility Guidelines (ADAAG).

Detectable warnings shall consist of a surface of truncated domes and shall comply with the following:

1. Dome Size: Truncated domes in a detectable warning surface shall have a base diameter of 0.9 inch (23 mm) minimum and 1.4 inches (36 mm) maximum, a top diameter of 50 percent of the base diameter minimum to 65 percent of the base diameter maximum, and a height of 0.2 inch (5.1 mm).
2. Dome Spacing: Truncated domes in a detectable warning surface shall have a center-to-center spacing of 1.6 inches (41 mm) minimum and 2.4 inches (61 mm) maximum, and a base-to-base spacing of 0.65 inch (17 mm) minimum, measured between the most adjacent domes on a square grid.

See Standard Plan Number 422a for truncated domes detail.

Unless the Contract specifies otherwise, the detectable warning shall extend the full width of the curb ramp (exclusive of flared sides) and shall extend either the full depth of the curb ramp or 24 inches (610 mm) deep minimum measured from the back of the curb on the ramp surface. The truncated dome pattern shall be perpendicular to the long axis of the ramp.

The detectable warning plate shall meet the following requirements:

1. "City of Seattle Safety Yellow" (Federal Standard 595 Color FS 23594) in color;
2. ASTM Compressive strength of 10,000 psi unless otherwise approved;
3. Slip resistance<sup>1</sup>, wet and dry of 0.80 minimum (ASTM C 1028);
4. resistant to breakage, fading, permanent deformation, and loss due to abrasion;
5. durable, high impact resistant, and possess thermal and moisture stability; and,
6. Approval by the Engineer.

<sup>1</sup> coefficient of friction on top of domes and on field area.

### **9-36.2 DETECTABLE WARNING PLATE – CAST-IN-PLACE**

Acceptable cast-in-place Materials are:

1. CASTinTACT® by Masons Supply Company, pre-stained and sealed with Miracote® Mirastain II "City of Seattle Safety Yellow" and Mascoseal Silane 40. A local Supplier of CASTinTACT is MASCO; 425-487-6161 ([www.masco.net](http://www.masco.net));
2. Cast-In-Place System by Armor-Tile™ Tactile Systems. A Seattle Supplier is White Cap Construction Supply; (206) 783-8400 ([www.armor-tile.com](http://www.armor-tile.com));
3. Step-Safe® as manufactured by Castek, Inc. a subsidiary of Transpo Industries; (914) 636-1000 ([www.transpo.com](http://www.transpo.com));
4. Cast-In-Place Composite Paver Tiles by ADA Solutions, (800) 372-0519 ([www.adatale.com](http://www.adatale.com));
5. ADA Replaceable (Wet-Set) Composite Tactile by ADA Solutions, (800) 372-0519 ([www.adatale.com](http://www.adatale.com)); or,
6. An approved equal; for products other than named above, the Contractor shall provide the Engineer with a submittal on the alternate Material as specified in Section 9-36.4. See Section 8-14.3(7)B.

**9-36.3 DETECTABLE WARNING PLATE RETROFIT – SURFACE APPLIED**

The warning pattern shall be capable of being bonded to an existing cement concrete surface. The surface of the warning pattern, excluding the domes, shall not be more than 3/8-inch above the surface of the concrete after installation.

Acceptable surface applied Materials are:

1. Surface Applied Systems by Armor-Tile™ Tactile Systems. A Seattle Supplier is White Cap Construction Supply; (206) 783-8400 ([www.armor-tile.com](http://www.armor-tile.com));
2. Surface-Mount / Retrofit Detectable Warning Tiles by ADA Solutions, (800) 372-0519 ([www.adatile.com](http://www.adatile.com));
3. TopMark® as manufactured by Flint Trading, Inc: (336) 475-6600 ([www.flintrading.com](http://www.flintrading.com)); or,
4. An approved equal; for products other than named above, the Contractor shall provide the Engineer with a submittal on the alternate Material as specified in Section 9-36.4. See Section 8-14.3(7)B.

**9-36.4 “APPROVED EQUAL” REQUIREMENTS**

Should the Contractor propose an “or equal” Material to those Materials named in Sections 9-36.2 and 9-36.3, the Contractor shall make the following submittal to the Engineer for approval at least 5 Working Days in advance in accordance with Section 1-05.3:

1. All information required in Section 8-14.3(7)B;
2. Two (2) rectangular or square samples of the “or equal” material with minimum 6 inch by 6 inch dimensions; color acceptance will be based on Engineer comparison to “City of Seattle Safety Yellow” comparison chip (SPU lab).
3. For the detectable warning retrofit plate, include information on the bonding material and its performance.
4. Documentation of the testing laboratory accreditation by a testing standards organization recognized by ASTM, the National Cooperation for Laboratory Association (NACLA) or approved by the Engineer.
5. At least 5 hard copies of the installation instruction or manual.

**SECTION 9-37 CONSTRUCTION GEOTEXTILES****9-37.1 GEOTEXTILE AND THREAD FOR SEWING**

The material shall be a geotextile consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties as indicated in Tables 1 through 6 for each use specified in the Contract. Specifically, the geotextile uses included in this Section and their associated tables of properties are as follows:

GEOTEXTILE APPLICATION	APPLICABLE PROPERTY TABLES
Underground Drainage, Low Survivability, Classes A, B, and C	Tables 1 and 2
Underground Drainage, Moderate Survivability, Classes A, B, and C	Tables 1 and 2
Separation	Table 3
Soil Stabilization	Table 3
Permanent Erosion Control, Moderate Survivability, Classes A, B, and C	Tables 4 and 5
Permanent Erosion Control, High Survivability, Classes A, B, and C	Tables 4 and 5
Ditch Lining	Table 4
Temporary Silt Fence	Table 6

Thread used for sewing shall consist of high strength polypropylene, polyester, or polyamide. Nylon threads will not be allowed. The thread used to sew permanent erosion control geotextiles shall be resistant to ultraviolet radiation. The thread shall be of contrasting color to that of the geotextile itself.

**9-37.2 GEOTEXTILE PROPERTIES****TABLE 1**

Geotextile for underground drainage strength properties for survivability.

		<b>GEOTEXTILE PROPERTY REQUIREMENTS<sup>1</sup></b>	
<b>GEOTEXTILE PROPERTY</b>	<b>TEST METHOD<sup>2</sup></b>	<b>LOW SURVIVABILITY WOVEN / NONWOVEN</b>	<b>MODERATE SURVIVABILITY WOVEN / NONWOVEN</b>
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D 4632	180 lbs. / 115 lbs. min.,	250 lbs. / 160 lbs. Min
Grab Failure Strain, in machine and x-machine direction	ASTM D 4632	<50% / /50%	<50% / /50%
Seam Breaking Strength	ASTM D 4632 <sup>3</sup>	160 lbs. / 100 lbs. min.	220 lbs. / 140 lbs. Min.
Puncture Resistance	ASTM D 4833	67 lbs. / 40 lbs. min.	80 lbs. / 50 lbs. Min.
Tear Strength, min. in machine and x-machine direction	ASTM D 4533	67 lbs. / 40 lbs. min	80 lbs. / 50 lbs. Min.
Ultraviolet (UV) Radiation stability	ASTM D 4355	50% strength retained min., after 500 hrs. in weatherometer	50% strength retained min., after 500 hrs. in weatherometer

See Notes after Table 6, this Specification.

**TABLE 2**

Geotextile for underground drainage filtration properties.

		<b>GEOTEXTILE PROPERTY REQUIREMENTS<sup>1</sup></b>		
<b>GEOTEXTILE PROPERTY</b>	<b>TEST METHOD<sup>2</sup></b>	<b>CLASS A</b>	<b>CLASS B</b>	<b>CLASS C</b>
AOS	ASTM D 4751	.43 mm max. (No. 40 sieve)	.25 mm max. (No.60 sieve)	.18 mm max. (No.80 sieve)
Water Permittivity	ASTM D 4491	.5 sec <sup>-1</sup> min.	.4 sec <sup>-1</sup> min.	.3 sec <sup>-1</sup> min.

See Notes after Table 6, this Specification.

**TABLE 3**

Geotextile for separation or soil stabilization.

		<b>GEOTEXTILE PROPERTY REQUIREMENTS<sup>1</sup></b>	
<b>GEOTEXTILE PROPERTY</b>	<b>TEST METHOD<sup>2</sup></b>	<b>SEPARATION WOVEN/NONWOVEN</b>	<b>SOIL STABILIZATION WOVEN/NONWOVEN</b>
AOS	ASTM D 4751	.60 mm max. (No. 30 sieve)	.43 mm max. (No. 40 sieve)
Water Permittivity	ASTM D 4491	.02 sec <sup>-1</sup> min.	.10 sec <sup>-1</sup> min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D 4632	250 lbs. / 160 lbs. min.	315 lbs./200 lbs. Min.
Grab Failure Strain, in machine and x-machine direction	ASTM D 4632	<50% / /50%	<50% / /50%
Seam Breaking Strength	ASTM D 4632 <sup>2</sup>	220 lbs. / 140 lbs. min.	270 lbs./180 lbs. Min.
Puncture Resistance	ASTM D 4833	80 lbs. / 50 lbs. min.	112 lbs./79 lbs. Min.
Tear Strength, min. in machine and x-machine direction	ASTM D 4533	80 lbs. / 50 lbs. min.	112 lbs./79 lbs. Min.
Ultraviolet (UV) Radiation stability	ASTM D 4355	50% strength retained min., after 500 hrs. in weatherometer	50% strength retained min., after 500 hrs. in weatherometer

See Notes after Table 6, this Specification.

**TABLE 4**  
Geotextile for permanent erosion and ditch lining.

		<b>GEOTEXTILE PROPERTY REQUIREMENTS<sup>1</sup></b>		
		<b>PERMANENT EROSION CONTROL</b>		<b>DITCH LINING</b>
<b>GEOTEXTILE PROPERTY</b>	<b>TEST METHOD<sup>2</sup></b>	<b>MODERATE SURVIVABILITY WOVEN / NONWOVEN</b>	<b>HIGH SURVIVABILITY WOVEN / NONWOVEN</b>	<b>WOVEN / NONWOVEN</b>
AOS	ASTM D 4751	See Table 5	See Table 5	.60 mm max (No. 30 sieve)
Water Permittivity	ASTM D 4491	See Table 5	See Table 5	.02 sec <sup>-1</sup> min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D 4632	250 lbs. / 160 lbs. min	315 lbs. / 200lbs.min.	250 lbs. / 160 lbs. min.
Grab Failure Strain, in machine and x-machine direction	ASTM D 4632	15%- 50% / > 50%	15%- 50% / > 50%	<50% / ≥ 50%
Seam Breaking Strength	ASTM D 4632 <sup>3</sup>	220 lbs./ 140 lbs. min.	270 lbs. / 180 lbs. min.	220 lbs. / 140 lbs. min.
Burst Strength	ASTM D 3786	400 psi/ 190 psi min.	500 psi / 320 psi min.	-----
Puncture Resistance	ASTM D 4833	80 lbs./ 50 lbs. min.	112 lbs. / 79 lbs. min.	80 lbs. / 50 lbs. min.
Tear Strength, min. in machine and x-machine direction	ASTM D4533	80 lbs./ 50 lbs. min.	112 lbs. / 79 lbs. min.	80 lbs. / 50 lbs. min.
Ultraviolet (UV) Radiation stability	ASTM D 4355	70% strength retained min., after 500 hrs. in weatherometer	70% strength retained min., after 500 hrs. in weatherometer	70% strength retained min., after 500 hrs. in weatherometer

See Notes after Table 6, this Specification.

**TABLE 5**  
Filtration properties for geotextile for permanent erosion control.

		<b>GEOTEXTILE PROPERTY REQUIREMENTS<sup>1</sup></b>		
<b>GEOTEXTILE PROPERTY</b>	<b>TEST METHOD<sup>2</sup></b>	<b>CLASS A</b>	<b>CLASS B</b>	<b>CLASS C</b>
AOS	ASTM D4751	0.43 mm max. (No.40 sieve)	0.25 mm max. (No.60 sieve).	0.22 mm max. (No. 70 sieve)
Water Permittivity	ASTM D4491	0.7 sec <sup>-1</sup> min.	0.4 sec <sup>-1</sup> min.	0.2 sec <sup>-1</sup> min.

See Notes after Table 6, this Specification.

**TABLE 6**  
Geotextile for temporary silt fence.

		<b>GEOTEXTILE PROPERTY REQUIREMENTS<sup>1</sup></b>	
<b>GEOTEXTILE PROPERTY</b>	<b>TEST METHOD<sup>2</sup></b>	<b>UNSUPPORTED BETWEEN POSTS</b>	<b>SUPPORTED BETWEEN POSTS WITH WIRE OR POLYMERIC MESH</b>
AOS	ASTM D 4751	for slit film wovens .60 mm max. (No. 30 sieve) for all other geotextile types .30 mm max. (No. 50 sieve) .15 mm min.(No. 100 sieve)	for slit film wovens .60 mm max. (No. 30 sieve) for all other geotextile types .30 mm max. (No. 50 sieve) .15 mm min. (No. 100 sieve)
Water Permittivity	ASTM D 4491	.02 sec <sup>-1</sup> min.	.02 sec <sup>-1</sup> min.
Grab Tensile Strength, min. in machine and x-machine direction	ASTM D 4632	180 lbs. min. in machine direction, 100 lbs. min. in x-machine direction	100 lbs. Min
Grab Failure Strain, min. in machine direction only	ASTM D 4632	30% max. at 180 lbs. or more	-----
Ultraviolet (UV) Radiation Stability	ASTM D 4355	70% Strength retained min., after 500 hrs. in weatherometer	70% Strength retained min., after 500 hrs. in weatherometer

**Notes** <sup>1</sup> All geotextile properties in Tables 1 through 6 are minimum average roll values (i.e., the test result for any sampled roll in a lot shall meet or exceed the values shown in the table).

<sup>2</sup>The test procedures used are essentially in conformance with the most recently approved ASTM geotextile test procedures, except for geotextile sampling and specimen conditioning, which are in accordance with WSDOT Test Methods 914 and 915, respectively.

<sup>3</sup>With seam located in the center of 8-inch long specimen oriented parallel to grip faces.

### **9-37.3 AGGREGATE CUSHION FOR PERMANENT EROSION CONTROL GEOTEXTILE**

Aggregate cushion for permanent erosion control geotextile, Class A shall meet the requirements of Section 9-03.9(2). Aggregate cushion for permanent erosion control geotextile, Class B or Class C, shall meet the requirements of Section 9-03.9(3) and 9-03.9(2).

### **9-37.4 GEOTEXTILE APPROVAL AND ACCEPTANCE**

#### **9-37.4(1) SOURCE APPROVAL**

For each geotextile application, the Contractor shall submit to the Engineer for approval, the manufacturer's name, address, the geotextile full product name, and the geotextile structure including fiber/yarn type.

If the geotextile source has not been previously evaluated, a sample of each proposed geotextile shall be submitted to the Engineer for evaluation. After the sample and required information for each geotextile type has been received by the Engineer, a maximum of 14 calendar Days will be required for this testing. Source approval will be based on conformance to the applicable values from Tables 1 through 6 in Section 9-37.2.

Source approval shall not be the basis of acceptance of specific lots of Material unless the lot sampled can be clearly identified and the number of samples tested and approved meet the requirements of WSDOT Test Method 914.

#### **9-37.4(2) GEOTEXTILE SAMPLES FOR SOURCE APPROVAL AND ENGINEER TESTING**

Each sample shall have minimum dimensions of 5 feet by the full roll width and shall be a minimum 6 square yards. The machine direction shall be marked clearly on each sample and is defined as the direction perpendicular to the axis of the geotextile roll. Source approval for temporary silt fences will be by Manufacturer's Certificate of Compliance (Section 1-06.3).

Samples shall be cut from the geotextile roll by a suitable method that produces a smooth geotextile edge without edge ripping or tearing. The samples shall not be taken from the outer wrap of the roll nor the inner wrap of the core.

#### **9-37.4(3) ACCEPTANCE SAMPLES**

Samples will be taken by the Engineer at the Project Site to confirm the geotextile meets the specified properties.

Approval will be based on testing of samples from each lot. A "lot" shall be defined for the purposes of this Specification as all geotextile rolls within the consignment (i.e., all rolls sent to the Project Site) which were produced by the same manufacturer during a continuous period of production at the same manufacturing plant and have the same product name. After receipt of the samples by the Engineer, a maximum of 14 calendar Days will be required for testing. If the results of the testing show that a geotextile lot, as defined, does not meet the properties required for the specified use as indicated in Tables 1 through 6 in Section 9-37.2, the roll or rolls which were sampled will be rejected. Two additional rolls for each roll found defective from the lot tested will then be sampled at random by the Engineer for retesting. If retesting shows that any of the additional rolls tested do not meet the required properties, the entire lot will be rejected. If the test results from all the rolls retested meet the required properties, the entire lot minus the roll(s) which failed will be accepted. All geotextile with defects, deterioration, or damage will be rejected and shall be replaced shall be replaced at no expense to the Owner.

#### **9-37.4(4) ACCEPTANCE BY CERTIFICATE OF COMPLIANCE**

When the quantities of geotextile proposed for use in each geotextile application are less than or equal to the following amounts, acceptance shall be by Manufacturer's Certificate of Compliance:

<b>APPLICATION</b>	<b>GEOTEXTILE QUANTITY</b>
Underground Drainage	600 sq. yards
Soil Stabilization and Separation	1,800 sq. yards
Permanent Erosion Control	1,200 sq. yards
Temporary Silt Fence	All quantities

The Manufacturer's Certificate of Compliance shall include the manufacturer's name, current address, full product name, geotextile structure including fiber/yarn type, geotextile roll number, proposed use(s), and certified test results.

#### **9-37.4(5) APPROVAL OF SEAMS**

If the geotextile seams are to be sewn in the field, the Contractor shall provide a section of sewn seam which can be sampled by the Engineer before the geotextile is installed.

The seam sewn for sampling shall be sewn using the same equipment and procedures as are to be used to sew the production seams. If production seams are to be sewn in both the machine and cross-machine directions, the Contractor shall provide sewn seams for sampling which are oriented in both the machine and cross-machine directions. The seams sewn for sampling shall be at least 2 yards in length in each geotextile direction. If the seams are sewn in the factory, the Engineer will obtain samples of the factory seam at random from any of the rolls to be used. The seam assembly description shall be submitted by the Contractor to the Engineer and are to be included with the seam sample obtained for testing. This description shall include the seam type, stitch type, sewing thread type(s), and stitch density.

**SECTION 9-38 TEMPORARY TRAFFIC CONTROL MATERIALS****9-38.0 GENERAL REQUIREMENTS**

Temporary traffic control materials in this section consist of various traffic communication, channelization and protection items described in Section 1-10 and listed below:

1. Stop/Slow Paddles
2. Construction Signs
3. Wood Sign Posts
4. Sequential Arrow Signs
5. Portable Changeable Message Signs
6. Barricades
7. Traffic Safety Drums
8. Barrier Drums
9. Traffic Cones
10. Tubular Markers
11. Warning Lights and Flashers
12. Truck-Mounted Attenuator
13. Portable Temporary Traffic Control Signal
14. Tall Channelizing Devices

The Contractor's TCM and TSC shall be responsible for assuring that temporary traffic control devices and materials comply with these specifications. Certification for crashworthiness according to NCHRP 350 will be required as described in Section 1-10.2(5)B.

"MUTCD," as used in this section, shall refer to the latest WSDOT adopted edition of the Manual on Uniform Traffic Control Devices for Streets and Highways. The Revised Code of Washington (RCW) 47.36, Traffic Control Devices, requires traffic control devices along city streets to conform to the WSDOT adopted standards to the extent possible. In the event of conflicts between the MUTCD, and the Contract Documents, then the Contract Documents shall govern.

**9-38.1 STOP/SLOW PADDLES**

Paddles shall conform to the requirements of the MUTCD, except that the minimum width shall be 24-inches.

**9-38.2 CONSTRUCTION SIGNS**

Construction signs shall conform to the requirements of the MUTCD and shall meet the requirements of NCHRP Report 350 for Category 2 devices. Any sign/sign stand combination that satisfies these requirements will be acceptable. Post mounted Class A construction signs shall

conform to the requirements of this section and additionally shall conform to the requirements stated in Section 9-28.

All Class A and Class B signs shall utilize materials and be fabricated in accordance with Section 9-28. All regulatory signs having a red background (i.e. Stop, Yield, etc.) and all other regulatory information signs (i.e. Speed Limit, Traffic Fines Double in Work Zones, etc) shall have Type III or IV sheeting in urban areas. All signs having a green background (i.e. Exit arrow, etc.) shall have Type II sheeting for the background and Type III or IV sheeting for the letters, border, and symbols.

**9-38.3 WOOD SIGN POSTS**

Post sizes for construction signs shall be as follows:

**ONE POST INSTALLATION**

POST SIZE	MIN. SIGN SQ. FT.	MAX. SIGN SQ. FT.
4 x 4	-	16
4 x 6	17	20
6 x 6	21	25
6 x 8	26	31

**TWO POST INSTALLATION**

POST SIZE	MIN. SIGN SQ. FT.	MAX. SIGN SQ. FT.
4 x 4	-	16
4 x 6	17	36
6 x 6	37	46

6 x 8	47	75*
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\* The Engineer shall determine post size for permanent signs greater than 75 square feet.

Sign posts shall conform to the grades and usage listed below. Grades shall be determined by the current standards of the West Coast Lumber Inspection Bureau (WCLIB) or the Western Wood Products Association (WWPA).

- |    |                      |   |
|----|----------------------|---|
| A. | 4 x 4                | Construction grade (Light Framing, Section 122- b WCLIB)<br>or (Section 40.11 WWPA)                   |
| B. | 4 x 6                | No. 1 and better, grade (Structural Joists and Planks, Section<br>123-b WCLIB)or (Section 62.11 WWPA) |
| C. | 6 x 6, 6 x 8, 8 x 10 | No. 1 and better, grade (Posts and Timbers, Section 131-b WCLIB)<br>or (Section 80.11 WWPA)           |
| D. | 6 x 10, 6 x 12       | No. 1 and better, grade (Beams and Stringers, Section 130-b WCLIB)<br>or (Section 70.11 WWPA)         |

#### 9-38.4 SEQUENTIAL ARROW SIGNS

Sequential Arrow Signs shall meet the requirements of the MUTCD supplemented with the following:

1. Sequential arrow signs furnished for stationary lane closures on this project shall be Type C.
2. The color of the light emitted shall be yellow.
3. The dimming feature shall be automatic, reacting to changes in light without a requirement for manual adjustment.

#### 9-38.5 PORTABLE CHANGEABLE MESSAGE SIGNS

Portable Changeable Message Signs (PCMS) shall meet the requirements of the MUTCD and the following:

- A. The PCMS shall employ one of the following technologies:
  1. Fiber optic/shutter
  2. Light emitting diode
  3. Light emitting diode/shutter
  4. Flip disk
- B. Regardless of the technology, the PCMS shall meet the following general requirements:
  1. Be light emitting and shall not rely solely on reflected light. The emitted light shall be generated using fiber optic or LED technology.
  2. Have a display consisting of individually controlled pixels no larger than 2½-inch by 2½-inch. If the display is composed of individual character modules, the space between modules shall be minimized so alphanumeric characters of any size specified below can be displayed at any location within the matrix.
  3. When activated, the pixels shall display a yellow or orange image. When not activated, the pixels shall display a flat black image that matches the background of the sign face.
  4. Be capable of displaying alphanumeric characters that are a minimum of 18-inches in height. The width of alphanumeric characters shall be appropriate for the font. The PCMS shall be capable of displaying three lines of eight characters per line with a minimum of one pixel separation between each line.
  5. The PCMS message, using 18-inch characters, shall be legible by a person with 20/20 corrected vision from a distance of not less than 800-feet centered on an axis perpendicular to the sign face.
  6. The sign display shall be covered by a stable, impact resistant polycarbonate face. The sign face shall be non-glare from all angles and shall not degrade due to exposure to ultraviolet light.
  7. Be capable of simultaneously activating all pixels for the purpose of pixel diagnostics. Any sign that employs flip disk or shutter technology shall be programmable to activate the disks/shutters once a day to clean the electrical components. This feature shall not occur when the sign is displaying an active message.
  8. The light source shall be energized only when the sign is displaying an active message.
  9. Primary source of power shall be solar power with a battery backup to provide continuous operation when failure of the primary power source occurs.

10. The sign controller software shall be NTCIP compliant.

The PCMS panels and related equipment shall be permanently mounted on a trailer with all controls and power generating equipment.

The PCMS shall be operated by a controller that provides the following functions:

1. Select any preprogrammed message by entering a code.
2. Sequence the display of at least five messages.
3. Blank the sign.
4. Program a new message, which may include animated arrows and chevrons.
5. Mirror the message currently being displayed or programmed.

#### **9-38.6 BARRICADES**

Barricades shall conform to the requirements of the MUTCD supplemented by the further requirements of the Contract Drawings or Standard Plans when provided.

#### **9-38.7 TRAFFIC SAFETY DRUMS**

Traffic safety drums shall conform to the requirements of the MUTCD and shall have the following additional physical characteristics:

- |    |               |   |
|----|---------------|---|
| 1. | Material      | Fabricated from low-density polyethylene that meets the requirements of ASTM D 4976 and is UV stabilized. |
| 2. | Overall Width | 18-inch minimum regardless of orientation.  |
| 3. | Shape         | Rectangular, hexagonal, circular, or flat-sided semi-circular.  |
| 4. | Color         | The base color of the drum shall be fade resistant safety orange.   |

The traffic safety drums shall be designed to accommodate at least one portable light unit. The method of attachment shall ensure that the light does not separate from the drum upon impact.

Drums and light units shall meet the crashworthiness requirements of NCHRP 350 as described in Section 1-10.2(5)B.

When recommended by the manufacturer, drums shall be treated to ensure proper adhesion of the reflective sheeting. Retroreflective bands shall be fabricated from Type III or Type IV reflective sheeting as described in Section 9-38.15.

#### **9-38.8 BARRIER DRUMS**

Barrier drums shall be small traffic safety drums, manufactured specifically for traffic control purposes to straddle a concrete barrier and shall be fabricated from low density polyethylene that meets the requirements of ASTM D 4976 and is UV stabilized.

The barrier drums shall meet the following general Specifications:

- |                              |  |
|------------------------------|--|
| Total height                 | 22 in., ± 1 in.                            |
| Cross-section                | hollow oval 10 in. X 14 in., ± 1 in.       |
| Formed support legs length   | 3 in., ± 1 in.                             |
| Space between legs           |  |
| (taper to fit conc. barrier) | 6¼ in. min.                                |
| Weight                       | 33 lb. ± 4 lb. with legs filled with sand. |
| Color                        | Fade resistant safety orange.              |

Barrier drums shall have three 4-inch retro-reflective white bands, (one complete and two partial). Bands shall be fabricated from Type III or Type IV reflective sheeting as described in Section 9-38.15.

#### **9-38.9 TRAFFIC CONES**

Cones shall conform to the requirements of the MUTCD, except that the minimum height shall be 28-inches.

Retroreflective bands shall be fabricated from Type III or Type IV reflective sheeting as described in 9-38.15.

#### **9-38.10 TUBULAR MARKERS**

Tubular markers shall conform to the requirements of the MUTCD, except that the minimum height shall be 28-inches.



The devices shall be stabilized by affixing them to the pavement by using either weighted bases or adhesive. Adhesive used to glue the device to the pavement shall meet the requirements of Section 9-26.2. Retroreflective bands shall be fabricated from Type III or Type IV reflective sheeting as described in Section 9-38.15.

#### **9-38.11 WARNING LIGHTS AND FLASHERS**

Warning lights and flashers shall conform to the requirements of the MUTCD.

#### **9-38.12 TRUCK-MOUNTED ATTENUATOR**

The Truck-Mounted Attenuator (TMA) shall be selected by the Contractor as required, or as indicated in the Contract Documents. The TMA shall be mounted on a vehicle with a minimum weight of 15,000 pounds and a maximum weight in accordance with the manufacturer's recommendations. Ballast used to obtain the minimum weight requirement, or any other object that is placed on the vehicle shall be securely anchored such that it will be retained on the vehicle during an impact. The Contractor shall provide certification that the unit complies with NCHRP 350 Test level 3 requirements.

The TMA shall have an adjustable height so that it can be placed at the correct elevation during usage and to a safe height for transporting. If needed, the Contractor shall install additional lights to provide fully visible brake lights at all times.

The TMA unit shall have a chevron pattern on the rear of the unit. The standard chevron pattern shall consist of 4-inch yellow stripes, alternating non-reflective black and retro-reflective yellow sheeting, slanted at 45 degrees in an inverted "V" with the "V" at the center of the unit.

#### **9-38.13 TALL CHANNELIZING DEVICES**

Tall channelizing devices shall meet the requirements of the MUTCD Part VI for channelizing devices and shall conform to these general Specifications:

1. Fabricated of fade resistant, safety orange color, low-density polyethylene that is resistant to deformation upon impact and meets the requirements of ASTM D 4976 and is UV stabilized.
2. Forty-two inches in height minimum, using a tapered cone type shape of consistent dimensions regardless of orientation to traffic.
3. Four-inches in width minimum at the top and 8-inches in width minimum at the base, which incorporates a separate ballast that is designed to resist overturning or other movement from wind gusts or other external forces.
4. Four retroreflective 6" wide horizontal bands, alternating orange and white beginning 6" from the top of the device. Retroreflective bands shall be fabricated from Type III or Type IV reflective sheeting as described in Section 9-38.15.
5. Warning lights are not required unless specifically shown on the traffic control Plan but provisions for securely attaching a warning light are required. The method of attachment shall ensure that the light does not separate from the device upon impact and light units shall meet the crashworthiness requirements of NCHRP 350 as described in Section 1-10.2(5)B.
6. Devices shall be regularly maintained to ensure that they are clean and the reflective sheeting is in good condition.

Except for the Specifications and requirements specifically listed above, Tall Channelizing Devices are defined to be Traffic Cones. All non-conflicting Contract provisions related to "Cones" shall apply to Tall Channelizing Devices.

#### **9-38.14 PORTABLE TEMPORARY TRAFFIC CONTROL SIGNAL**

Portable traffic control signals shall meet the requirements of the MUTCD and these specifications.

The portable temporary traffic control signal shall be fully operational for two-phase traffic actuated, pre-timed, or manual control. The portable temporary traffic control signal shall conform to the following requirements:

1. Controllers shall demonstrate conflict-monitoring capability, consistent with the requirements of Section 9-38.14(A), with a flashing red display in both directions. The portable traffic control signal shall be capable of terminating the movement one (1) or movement two (2) all red clearance, in order to repeat the previous movements operation.
2. Signal head displays shall be either hard wired or controlled by radio signal. Manual operation will not require hardwiring or radio control except for the use of two-way radio communication by manufacturer trained qualified operators.
3. The system shall be equipped with a means of informing the operator of signal indications, such as a light on the back of each signal head that illuminates when the signal displays a red indication, during manual operation.

4. A vehicle detection system is required. The system shall be capable of operating either as fixed time or traffic actuated controller. The detection system shall provide presence detection (continuous call to the controller) while there is a vehicle in the detection zone.
5. Signal supports used with portable traffic control signals shall provide a minimum of two signal displays, spaced a minimum of 8 feet apart. When trailer mounted portable traffic signals are used to provide alternating one-way control, a minimum of one of the signal displays shall be suspended over the traveled way. The minimum vertical clearance to the traveled way for this signal display is 16.5 feet. Vehicular signal heads shall be of the conventional type with standard ITE approved, 12-inch ball LED display. Tunnel visors shall be provided for all indications. The system shall include a countdown display capable of a 199 second countdown clock for motorist information when there is no direct line of sight between the stop bar locations.
6. Back plates shall be furnished and attached to the signal heads. Back plates shall be constructed of 5 inch wide .050 inch thick corrosion resistant louvered aluminum, with a flat black finish. A highly retroreflective strip, 3-in wide, shall be placed around the perimeter of the face of all vehicle signal backplates to project a rectangular image at night towards oncoming traffic.
7. Trailers shall have a leveling jack installed at all four corners. The crank for the leveling jacks and trailer hitch shall be locked. The signal pole and mast arm assemblies shall be of the collapsible type, which can be erected and extended at the job site. The mast arm assemblies shall be firmly attached to the trailer to form a stable unit, which can withstand an 80 mph design wind speed with a 1.3 gust factor.
8. The portable temporary traffic control signal shall be powered using a self-contained battery system capable of providing over 12 Days of continuous operations without solar array assistance. A solar panel array will be allowed.

#### **9-38.14(A) FLASHING OPERATIONS**

All temporary traffic signals shall be equipped for flashing operation of signal displays. Controllers shall be programmed for flashing red displays for all approaches. During flash display, all pedestrian circuits shall be de-energized.

Actuated traffic signal control mechanisms shall be capable of entry into flash operation and return to normal operation as follows:

1. Terminal Strip Input (Remote Flash). When called as a function of a terminal strip input, the controller shall provide both sequenced entry into flash and sequenced return to normal operation consistent with the requirements of the latest edition of the Manual on Uniform Traffic Control Devices.
2. Police Panel Switch. When the flash-automatic switch located behind the police panel door is turned to the flash position, the signals shall immediately revert to flash; however, the controller shall "STOP TIME." When the switch is placed on automatic, the signals shall immediately time an 8-10 second all red period then resume normal cyclic operations at the beginning of major street green.
3. Controller Cabinet Switches. When the flash-automatic switch located inside the controller cabinet is placed in the flash position, the signals shall immediately revert to flash; however, the controller shall continue to function. When the flash-automatic switch is placed in the automatic position, the controller shall immediately resume normal cyclic operation at the beginning of the artery green. Adjacent to the flash-automatic switch shall be a controller on-off switch. If the flash-automatic switch is in the automatic position and the controller on-off switch is placed in the OFF position, the signals shall immediately revert to flash.
4. Power Interruption. On "NEMA" controllers any power interruption longer than 475 plus or minus 25 milliseconds, signals shall re-energize consistent with No. 2 above to ensure an 8-second flash period prior to the start of major street green. A power interruption of less than 475 plus or minus 25 milliseconds shall not cause resequencing of the controller and the signal displays shall re-energize without change. Type 170 controllers shall re-energize consistent with No. 2 above after a power interruption of 1.75 plus or minus 0.25 seconds. The 8-second flash period will not be required.
5. Conflict Monitor. Upon sensing conflicting signals or unsatisfactory operation voltages, the conflict monitor shall immediately cause the signal to revert to flash; however, the controller shall stop time at the point of conflict. After the conflict monitor has been reset, the controller shall immediately take command of the signal displays at the beginning of major street green.

#### **9-38.15 TYPE III OR TYPE IV REFLECTIVE SHEETING**

Type III and Type IV reflective sheeting shall consist of spherical or prismatic lens elements adhered to a synthetic resin and encapsulated by a flexible, transparent, weatherproof plastic having a smooth outer surface. All sheeting shall be weather resistant and have a protected pre-coated adhesive backing.

The reflective sheeting shall have the following minimum coefficient of retroreflection values at 0.2 degrees and 0.5 degrees observation angle expressed as average candelas per foot-candle, per square foot of material. Measurements shall be conducted in accordance with ASTM E 810.

#### **TYPE III GLASS BEAD RETROREFLECTIVE ELEMENT MATERIAL**

OBS. ANGLE	ENTRANCE ANGLE	SILVER WHITE	YELLOW	ORANGE	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	100	45	45	20	12
0.2°	+30°	150	100	60	25	25	11	8.5
0.5°	-4°	95	62	30	15	15	7.5	5.0
0.5°	+30°	65	45	25	10	10	5.0	3.5

**TYPE IV MICRO PRISMATIC RETROREFLECTIVE ELEMENT MATERIAL**

OBS. ANGLE	ENTRANCE ANGLE	WHITE	YELLOW	GREEN	RED	BLUE	BROWN
0.2°	-4°	250	170	35	35	20	7.0
0.2°	+30°	80	54	9	9	5.0	2.0
0.5°	-4°	135	100	17	17	10	4.0
0.5°	+30°	55	37	6.5	6.5	3.5	1.4

1. The standard rainfall test specified in Federal Specification LS 300C and the brightness of the reflective sheeting totally wet by rain shall not be less than 90 percent of the above values.
2. Samples shall be submerged in a tank of clean water (approximately 72°F) for a period of 5 minutes. Reflex-reflective performance of the sheeting shall be viewed in a darkened room by reflected light through the surface of the water or through a transparent plane surface of the tank parallel to the sample surface. Light source shall be such as a hand flashlight held close to the eye. The wet sheeting shall show no apparent loss of reflective performance as compared to dry material.

The diffuse day color of the reflective sheeting shall be visually evaluated by comparison with the applicable Highway Color Tolerance Chart. Color comparison shall be made under north daylight or a scientific daylight having a color temperature from 6500 degrees to 7500 degrees Kelvin. Daytime color evaluation shall be illuminated at 45 degrees and viewed at 90 degrees. There shall be no significant color shift when viewed under nighttime (retroreflective) conditions.